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&

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SCIENTIFIC NEWS

CONDUCTED BY MAJOR B. BADEN-POWELL AND E. S. GREW M.A

"*Let Knowledge grow from more to more*"
—TENNYSON.

Volume I.

JANUARY TO DECEMBER, 1904.

NEW SERIES

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CONTENTS.

CENTRAL ASIA AND TIBET.*

Dr. Sven Hedin is without doubt the most remarkable explorer now living. From an early age he adopted exploration as a profession, and Asia as a speciality. His training to this end has made him able to perform single-handed most extensive journeys into unknown parts of Central Asia, which have yielded splendid scientific results. His organising powers are great. As a topographer he has no rival, while he is also able to undertake successfully the work of a meteorologist, geologist, biologist, ethnologist, archæologist, and many other specialities, and thus is empowered to give an accurate picture of the country through which he travels.

The scientific results of his latest expedition have still to be worked out, and their publication in detailed form is, we are glad to say, assured. In the present volumes we have only the narrative of his travels, with an inkling of what is to come in the way of valuable scientific results.

It is possible in the limits of this notice to give only a general idea of Dr. Hedin's journeyings. From the middle of 1899 to the middle of 1902 he was travelling almost incessantly, his various routes in Asia extending to a total of some 6000 miles. The narrative of these journeys, contained in these two fine volumes of over 600 pages each, is in the form of an orderly journal, solid with fact and detail, but at the same time vividly written, so that one's interest in the chronicles of each day's doings is held to the end. The narrative, in fact, not only gives a lifelike picture of the country through which the explorer passed, and of how he got through it, but reveals besides many a deep insight into Asiatic character, while of his own character the author unconsciously draws a most interesting picture—great determination and dogged pluck, with now and again a suspicion of rashness, untiring energy, a keen foresight, cheerfulness under all circumstances, a singular humane and sympathetic nature, are among the characteristics displayed.

In August, 1899, Dr. Hedin reached Kashgar, in Turkestan. Equipping there a carefully-organized caravan, he proceeded to the Yarkand Daria, or Tarim, the great river which flows through the deserts of Eastern Turkestan. Here at Lailik began the first and perhaps most important part of his journeys. Converting with immense labour and great ingenuity a ferry boat into a floating residence and observatory, he committed himself to the broad waters of the lonely Tarim. The greater part of the first volume of the narrative is occupied by an account of this almost idyllic journey. But it was a journey of great geographical importance for the hitherto little known and badly-mapped Tarim is now, by the labours of Dr. Hedin, the best-mapped river out of Europe.

For months, day after day, as the boat floated down the great river, the author sat glued to his table, mapping on a large scale every twist and turn of the stream, checking and rechecking his measurements, frequently measuring the depth and width of the river, and the velocity and volume of its waters. As long as the boat was moving there was no time for relaxation. "I was never able to quit my post for an instant to stretch my legs. We hardly ever travelled more than ten minutes in a straight line. . . . Hence I had to keep my eyes upon the compass." But if the work was hard, and perhaps many would think monotonous, Dr. Hedin was enchanted by this voyage. The scenery in parts was beautiful. "The forest stretched right down to the very brink of the river. . . . . High up on the sky-line ran the green coping of the poplars' crowns, making a dense curtain of foliage which seldom allowed a glimpse of the tree-trunks to gleam between—green, but green shot with various shades of rich brown, so rich that they would have been harsh had their effect not been softened by the hazy sky behind them." But at other times the country through which the river ran was utterly barren, the soil being sand. And as the Great Takla Makan Desert was reached "we were engulfed in that awful Asiatic silence—a silence as of the dead. No greeting came to meet us from the heart of the desert. The river—the river alone—sang its rippling song to the irresponsive sand. . . . . Very strange to be crossing one of the earth's greatest deserts

* "Central Asia and Tibet. Towards the Holy City of Lassa." By Sven Hedin. (Hurst & Blackett.) 2 vols. Illustrated. £2 2s. net.

by water! Not so very long ago I had nearly died there for want of it."

And not only did the scenery change as they drifted on, but the fiery heats of summer were succeeded by the violent autumn storms, and then the winter crept steadily and remorselessly on. The surface of the river one morning was spangled with patches of ice. Then a fringe of ice crept out day after day further from the banks, and the air was full of murmurs from the grinding ice, but there was still time to go many miles before the passage was blocked completely by the ice. Then winter quarters were formed, and the caravan, which had made the long journey by land, was successfully joined. "Never," writes Dr. Hedin, "was a journey of that magnitude carried through so comfortably and so successfully." And we believe him, for with little danger and with no great difficulty for so resourceful and intrepid an explorer, a thousand miles of a practically unknown river was most minutely investigated in the space of some three months.

Dr. Hedin is not one to rest on his oars. No sooner had he got his winter quarters comfortably arranged than he started out on a perilous journey southwards across the Takla Makan Desert to Cherchen, situated on the river of that name. This desert journey in the middle of a very hard winter, with temperatures of many degrees below zero, and frequent blinding snow-storms, was a very trying piece of work, but it was accomplished with the loss of only one camel.

After an excursion to the south-west from Cherchen, which involved a very cold ride of 200 miles, Dr. Hedin brought his caravan back to his winter quarters, travelling for the most part by the ancient bed of the Cherchen River. Meanwhile his head-quarters camp had become "an important market, well known throughout all the Lop country, and immediately outside its precincts there grew up a ring of small 'suburbs,' where tailors, smiths, and other handicraftsmen came and plied their several trades." And Dr. Hedin became quite a king in the Lop country, and was able to set right many injustices to the poor.

In the springs of 1900 and 1901, Dr. Hedin turned his attention to the district of the famous Lop-nor and its sister lakes. His work here was very important and interesting. The Tarim empties itself into the great depression of the Lop Desert. It has been long suspected that the lake into which this great river discharges its waters has shifted from time to time. Dr. Hedin has amply proved this to be the fact, by an examination of the Kara-Koshun Lakes, into which the river now empties itself, and by a careful survey and levelling of that part of the desert in which the old lake was suspected to have existed. Moreover, he found that the present lake was actually travelling back to its old bed. "Nor is it surprising," he writes, "that such should be the case in this desert, which my survey proved to be almost perfectly horizontal. While the Lake of Kara-Koshun, which had existed a long time in its southern half, was being filled up with mud, drift-sand, and decaying vegetation, the arid northern half was being excavated and blown away by the winds, and thus being hollowed out to a deeper level. Now these changes of niveau are determined by purely mechanical laws and local atmospheric conditions; consequently the lake which serves as the terminal reservoir of the Tarim system, must be extremely sensitive to their influence. . . . Then vegetation and animal life, as well as the fishing population, inevitably accompany the water as it migrates, and the old lake-bed dries up." In connection with this last observation, Dr. Hedin made a most important historical discovery. In the spring of 1900 one of his men found by a lucky chance, in the middle of the desert, some old ruins. The next spring these were searched for and rediscovered. The material obtained from them has not yet been fully worked out, but enough has been done to show that this spot, on the shores of the ancient Lop-nor, was the site of Lôu-lan, an important country in olden times, since it was situated between the great northern highway and the great southern highway from China to Europe. Long known historically to the Chinese, its position hitherto has never been accurately fixed. "How different, how exceedingly different this region was now compared with what it must have been formerly! Here was now not a single fallen leaf; not a single desert spider. . . . There was only one power which brought sound and movement into these dreary, lifeless wastes, namely, the wind. . . . I can imagine how beautiful a spot it was—the temple . . . . embowerered amid the shady poplar groves, with an arm of the lake touching it. . . . Round about it were the scattered villages. . . . Southwards stretched far and wide the bluish-green waters of Lop-nor, set about with forest groves. . . . Look upon that picture and then look upon the picture of the scene as it is now! An endless array of cenotaphs! And why is this? It is simply because a river, the Tarim, has changed its course." For an account of the many difficulties, hardships, and dangers that the explorer and his party experienced in the exploration of this great desert and the surrounding country, we must refer our readers to the traveller's own modest but graphic account.

Dr. Hedin's next and last great journey was an exceedingly long and trying one across the northern part of Tibet. For this journey he organised an immense caravan of camels, horses, and asses, but so difficult was the country, and so great were the hardships, chiefly on account of most of the time being spent at great altitudes, that very few of these animals survived, while several men died from the same cause. Dr. Hedin is not one to make much of hardships and difficulties, and his statement with regard to this journey is therefore significant. "For my part," he writes, "I would rather cross the Desert of Gobi a dozen times than travel through Tibet once again in winter. It is impossible to form any conception of what it is like; it is a veritable *via dolorosa!*" And we might add that there would have been little chance of any less hardy or experienced traveller getting through at all. During this journey Dr. Hedin made a plucky dash towards Lassa in the disguise of a Mongol pilgrim. But the Dalai Lama had got wind of his big caravan far away in the mountains, and he was stopped very firmly, but certainly not unkindly, on the threshold almost of his goal, and eventually escorted back to his caravan. After this the Tibetans continually escorted the caravan, keeping a small army on its flank, and effectually preventing the explorer from going to the south. In view of our present advance into Southern Tibet, it is of interest to note that Dr. Hedin considers that the Tibetan's "policy of isolation during the last half century or so has not been dictated by religious, but by political motives. Their tactics, peaceful, but so far successful, have aimed at guarding their frontiers against Europeans." None but Europeans are tabooed. "Still Tibet will have to meet her destiny," says the author, and the day now seems near at hand

As to the narrative in general, we may say that it is a most engrossing account of a very remarkable series of explorations. The book is well produced in every way. It has most excellent maps, and the illustrations from the author's photographs (over which he took the greatest possible pains) and sketches are exceptionally good.—H. F. W.

FUNGI AS LINKS IN THE CHAIN OF LIFE.

I.—THE NATURE, HABITATS, AND DISTRIBUTION OF FUNGI.

By G. Massee.

Fungi include the mushrooms and toadstools, as well as moulds, mildews, truffles, puff-balls and yeasts, and number altogether between fifty and sixty thousand different kinds.

It is only by comparing their mode of life with that of other groups of plants that the true nature of fungi and their special characteristics can be clearly understood. Flowering plants, ferns, mosses, seaweeds and lichens, in fact all plants with the exception of fungi, possess chlorophyll; owing to the action of which they are enabled to use carbonic acid and other inorganic substances as food. Now the absence of chlorophyll must be considered as the most distinctive hall-mark of the fungi, and its absence implies their inability to utilize inorganic substances as food. This feature places fungi on a par with animals, inasmuch as both agree in requiring organic food. This fact is obvious in the case of those fungi that develop as parasites on living plants, as the destructive rusts and mildews on wheat, barley, and numerous other plants, both wild and cultivated. Neither would anyone doubt the statement in the case of fungi growing on, and consequently obtaining their food from rotten wood or dead leaves. The case is not at first sight so evident, where fungi, as the common mushroom, spring directly from the ground; when it might be supposed that the fungus obtained its food from the same source as the grass growing around it.

Careful examination, however, would reveal the fact that the spawn of the mushroom derived its food from the decaying portions of grass and humus present, and not from the soil. It will be remembered that when mushrooms are cultivated artificially, the spawn is placed in manure, which is organic matter, although dead and more or less decomposed, and is not to be compared to such inorganic substances as carbonic acid, obtained from the air, and certain salts derived from the soil, which furnish the grass with its food.

Now this condition of things naturally prevents the fungi from being pioneers in the dispersal of plant-life over the globe. Mosses, algae, and other simple forms of chlorophyll-bearing plants, requiring only moisture, air, and soluble rock constituents as food, can manage to grow in barren and hitherto lifeless regions, if their seeds happen to be carried by wind or other agents. This is not so with fungi, which, for the reasons already stated, require organic food.

There are no other fast lines between fungi and other members of the Vegetable Kingdom, all other distinctions being only differences of degree. Taking structure, we find that the characteristic unit, a cell with a well-defined wall or enclosing membrane, forms the groundwork of fungi, exactly as in all other plants, only in fungi the component cells are not differentiated into what are known as vessels, cork-cells, bast, &c., as in the higher plants. The reason for this absence of specialized structure in the fungi is the comparative absence of division of labour in these plants as compared with ferns and flowering plants.

To understand this point of difference it must be remembered that in all except the very simplest of plants, which often consist of a single microscopic cell, there is a well-marked division into a vegetative and a reproductive stage; and even in the simple one-celled plants alluded to above, the one cell constituting the individual spends the first period of its existence as a vegetative, and the last part as a reproductive body.

By the vegetative portion is meant all structures and work done for the welfare of the individual; whereas the reproductive phase is entirely for the purpose of producing other individuals of the same kind, usually from seeds.

Now if we take an oak tree as an example of one of the chlorophyll-bearing plants, the root, trunk, branches and leaves, in fact every part except the flowers and fruit, belong to the vegetative stage, in other words all the parts mentioned are necessary for the continuance of life in the

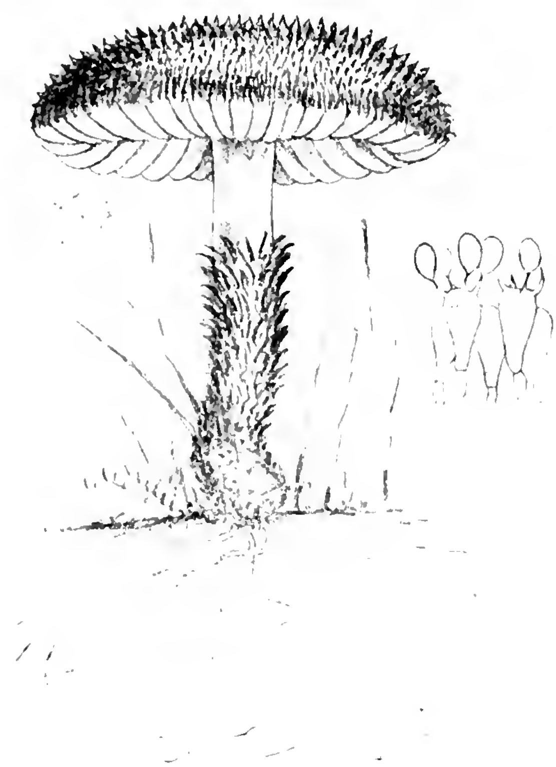


Fig. 1.—A typical Agaric or gill bearing fungus (*Agaricus hystrix*). The part above the ground-line is the reproductive portion; the part below is the vegetative portion. Natural size. The figure on the right shows two basidia bearing four spores each. Magnified 500 times.

individual tree under consideration. As the oak lives for many years, the division of labour, or different kinds of work necessary to enable it to do so, are many and varied. Of primary importance is a special arrangement for obtaining food from the air and the soil, converting the same finally into parts of the tree, and enabling the food to spread to every growing portion of the plant. Then, again, certain portions of the structure are told off for the purpose of giving strength to the whole fabric, so that the tree can withstand the force of the elements.

As there is a limit to the life of the oak tree, in common with every other living organism, some provision is necessary for the continuance of the same kind of tree in the future. This necessity is provided for by the production of flowers; these in the case of the oak eventually give origin to acorns, or seed, which in due course develop into other oak trees. This represents the reproductive cycle of the oak tree, and it will be remarked that, so far as volume

is concerned, it is very small compared to the permanent vegetative portion of the tree.

Now, as a rule, in fungi the above proportions of the vegetative and reproductive portions of the plant are reversed as compared with the oak tree; in other words, the reproductive portion of a fungus is much larger, and also more conspicuous than the vegetative portion.

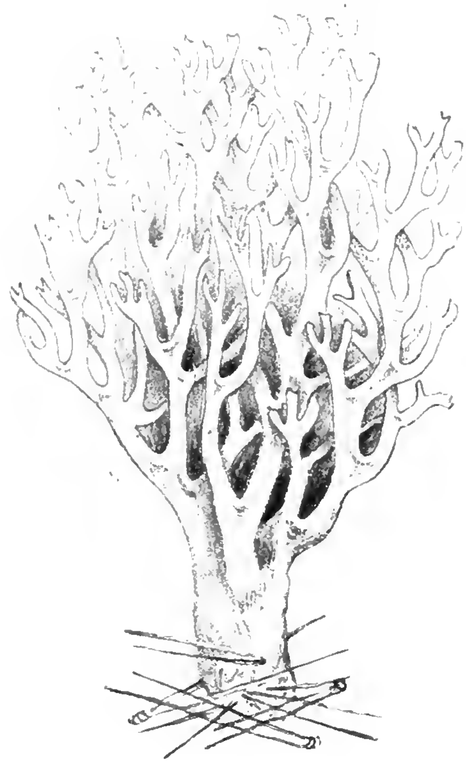


FIG. 2.—A second type of Basidiomycetes (*Clavaria abietina*). The entire branched portion is covered with basidia bearing spores. Common in our pine woods. Natural size.

If we take as an illustration the common mushroom, the aspect of which is familiar to most people, then what is presumably considered to represent the whole plant—namely, the stem, cap, and gills—only in reality represents the reproductive portion of the fungus, being, in fact, the exact equivalent in function of the flowers in the oak; the equivalents of seeds, called *spores* in the fungi, being produced on the surface of the gills. On the other hand, the vegetative portion of the mushroom consists of the comparatively small portion of white thread-like spawn or *mycelium* ramifying in the manure or other substance on which the fungus is growing.

The same arrangement of parts is practically true for all other fungi; the portion visible to the naked eye, however varied its form or colour, represents only the reproductive portion; whereas the vegetative part is buried in the substance from which the fungus obtains its food.

The popular belief that the mushroom and other fungi grow in a single night is not correct; it is quite true that when the mushroom has reached a certain stage of development, one or two days suffices for it to attain its full size after it appears above ground. Before this final spurt is reached, however, the baby mushroom has been growing for some weeks, and undergone various changes of structure and development before it emerges above ground. A little thought will recall to mind the fact that mushrooms do not spring up within two or three days after the formation of a mushroom bed, but several weeks elapse before the mushrooms are ready for the table.

As to the origin of the fungi, the opinion held at the present day is that they originated or evolved from the algæ or seaweeds, or their freshwater representatives.

The most primitive groups of fungi are aquatic in habitat, and closely resemble in structure certain algæ; in fact, at the beginning of the fungal group a fungus was an alga devoid of chlorophyll, the parasitic habit adopted by the pioneers of the fungi enabling them to dispense with this green substance. The sequence of evolution from these primitive types of fungi to the most modern members of the group—the agarics or gill-bearing fungi, and the puffballs—is fairly complete, and in evidence at the present day.

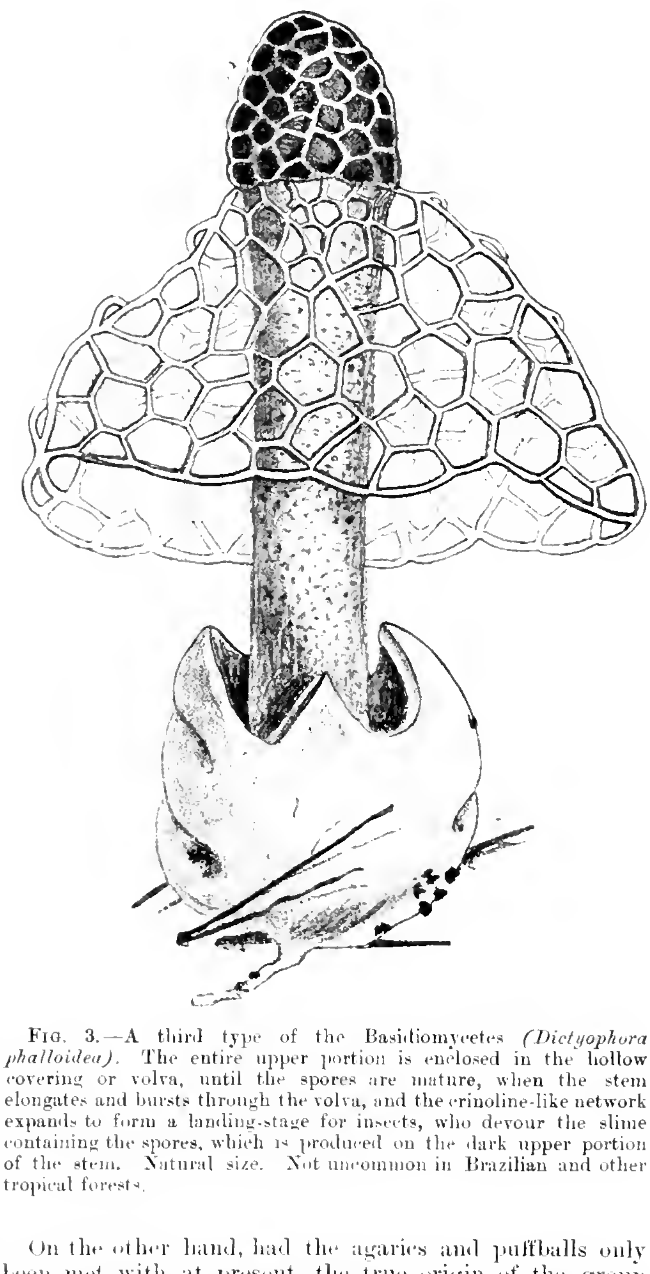


FIG. 3.—A third type of the Basidiomycetes *(Dictyophora phalloidea)*. The entire upper portion is enclosed in the hollow covering or volva, until the spores are mature, when the stem elongates and bursts through the volva, and the crinoline-like network expands to form a landing-stage for insects, who devour the slime containing the spores, which is produced on the dark upper portion of the stem. Natural size. Not uncommon in Brazilian and other tropical forests.

On the other hand, had the agarics and puffballs only been met with at present, the true origin of the group would never have been suspected, so completely have all traces of primordial structure and affinity been effaced,

combined with a complete loss of all trace of sexual reproduction.

The many causes combined to effect this remarkable change cannot be discussed here; suffice it to say that the transition from an aquatic to a terrestrial habitat is a main factor.

The fungi are primarily divided into two groups, depending on the mode of origin of the spores or reproductive bodies. In the first or older group, dating from their secession from the algae, the spores are produced inside special cells called *asci*, and the spores are technically described as *ascospores*. In the older representatives of this group, that is those nearest to the algae, there is a distinct mode of sexual reproduction, in many instances indistinguishable from that presented by many algae, but as the members invaded dry land the sexual mode of reproduction gradually disappeared, and is now comparatively rare; nevertheless the same general form of spore-producing structure is maintained.

Now as these fungi became more and more accustomed to existence on dry land, a most important addition to their means of reproduction gradually evolved. This consisted in the development of secondary kinds of reproductive bodies, technically called *conidia*. Now conidia more or less resemble ordinary spores in structure and appearance, but differ in not being a sexual product.

This group of fungi, collectively known as the Ascomycetes, includes many thousands of different kinds, large numbers of which are very minute, and known only to those specially interested in the study of the fungi.

Among kinds belonging to this group, and fairly well known, may be enumerated the Morels, Truffles, Yeasts, and certain of the minute forms popularly known as moulds and mildews.

The second large group, called the Basidiomycetes, have the spores borne on the surface of special cells called *basidia*, hence the spores are spoken of as *basidiospores*. In this group there is no vestige left of the sexual mode of reproduction. The representatives of this section are usually much larger in size than those of the Ascomycetes, and include such well-known forms as the common mushroom, toadstools, puffballs, and the woody, bracket-shaped or hoof-shaped fungi growing on trees. It has already been stated that secondary forms of fruit are produced by fungi, but it is necessary to enter more into detail respecting this matter, as the extremes to which this idea is carried out in certain groups has no parallel elsewhere in the vegetable kingdom.

In some fungi the different stages which together form the complete cycle of development are as different in general appearance and relative size as that between a poppy and an ash tree. Not only is this the case but the various forms usually grow at different periods of the year, one may be an annual and the other a perennial condition; and, finally, when parasites, the forms may grow on different kinds of host-plants.

As an instance of such multiplicity of forms representing phases in the life-cycle of an individual, may be mentioned the common and very destructive wheat rust. The spring stage of this fungus appears under the form of clusters of miniature cups with fringed edges, filled with orange spores, on living leaves of the barberry. The spores of this form are scattered by wind, and those that happen to alight on a blade of wheat soon germinate and enter the tissues, and in course of time produce minute streaks of a rust colour on the surface of the living leaf. The spores of this second condition, dispersed by wind, inoculate other wheat plants, and as the spores are produced in rapid succession throughout the summer, it can be readily understood how quickly an epidemic of disease can spread after a parasitic fungus has once secured an entrance. Towards the autumn, a third form of fruit is produced on the fading wheat leaves, quite different in appearance from either of the two stages previously mentioned. The spores of this third stage are called *resting spores*, because they remain unchanged until the following spring, when they germinate and inoculate young barberry leaves, which results in the production of the first stage of the fungus again, and the cycle of development proceeds as before.

Some fungi have two distinct forms in the life-cycle; some three, as wheat rust; some four or even more. In some instances, one form of the cycle can be omitted at times, as in the case of wheat rust, where the stage on barberry is dropped altogether in some countries.

Thousands of different fungi have the individual made up as it were of a number of distinct, different looking

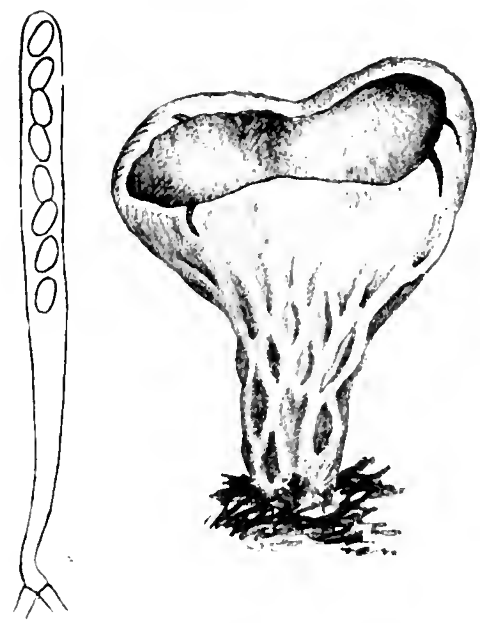


Fig. 4.—An example of the Ascomycetes (*Peziza acetabulum*). The asci line the inside of the cup. Natural size. On the left is an ascus containing eight spores. Magnified 500 times. Not uncommon on the ground in our woods.

parts growing at different periods of the year under different conditions, and fulfilling varied functions in the life of the complete plant. The use of the quickly-growing summer condition is to furnish an enormous number of spores, by which the fungus is enabled to extend its geographical distribution; whereas the autumn form, producing resting spores, is for the purpose of preserving the species in time, by bridging over the period when the plant on which the fungus is parasitic is not growing.

The various methods of spore dispersion as occurring in the fungi are interesting; only a few of the most pronounced can be noticed here. By far the most universal agent in effecting the distribution of spores is wind, as may be observed when a ripe puffball is crushed under foot. Insects are also answerable for the extension of many fungus epidemics, by alternately feeding on, or visiting diseased and healthy plants, and in so doing unconsciously conveying spores from one plant to another. Perhaps the most interesting instance occurs in a group of fungi to which our "stinkhorn" belongs. Most of the species are tropical, in this country we have only three representatives. In this group the reproductive portion

of the fungus often assumes most fantastic forms, and is generally brilliantly coloured. Over this framework is spread at maturity a dingy green, semi-fluid mass, intensely sweet to the taste, and, from the ordinary human standpoint, intensely fœtid; the exceedingly minute spores are imbedded in this substance, which is greedily devoured by various kinds of insects, mostly flies, who thus unconsciously diffuse the spores, as it has been shown that these are not injured by passing through the alimentary tract of an insect. It is interesting to note that in certain of the fungi the same advertisements in the guise of colour, sweet taste and smell, are used for the purpose of unconscious dispersion of the spores by insects, as are used by many flowering plants for the purpose of securing cross-fertilization, also through the agency of insects.

MODERN COSMOGONIES.*

VI.—WORLD-BUILDING OUT OF METEORITES.

By AGNES M. CLERKE.

THE idea is seductive that we see in every meteoric fire-streak a remnant of the process by which our world, and other worlds like or unlike it, were formed. It is not a new idea. Chladni entertained it in 1794; and it has since from time to time been revived and rehabilitated with the aid of improved theoretical knowledge and a larger array of facts. Survivals are tempting to thought. It costs less effort to realise differences in degree than differences of kind. The enhanced activity of familiar operations is readily imagined; while perplexity is apt to shroud the results of modes of working strange to experience. Hence the presumption in favour of continuity; nor can it be said, even apart from our own mental inadequacy, that the presumption is other than legitimate. Nature is chary of her plans, lavish of her materials. Her aims are characterized by a majestic unity, but she takes little account (that we can see) of surplusage or wreckage. Now it seems likely that meteorites represent one or the other of these two forms of waste stuff. They are analogous, apparently, either to the chips from shaped blocks, or to the dust and rubbish of their destruction. Let us consider what it is that we actually know about them.

It cannot be said that the sources of our information are scanty. Fully one hundred millions are daily appropriated by the earth as she peacefully pursues her way. Their absorption leaves her unaffected. It produces no perceptible change in her internal economy, and makes no sensible addition to her mass. The hundred millions of small bodies taken up have, nevertheless, in Professor Langley's opinion, an aggregate weight of more than one hundred tons.† And this increment is always going on. Yet its accumulated effect is evanescent by comparison with the enormous mass of our globe. That it was more considerable in past ages than it is at present, might be plausibly conjectured, but cannot reasonably be maintained. Geological deposits contain—unless by some rare exception—no recognizable meteoric ingredients. There is nothing to show that the earth was subject to a heavier bombardment from space during the Silurian era than in the twentieth century.

Meteorites signify their existence to us, in general, only by the bale-fires of their ruin; but in a few cases its actual relics come to hand. Those substantial enough to escape total disintegration through atmospheric resistance to their swift movements find their way to museums and laboratories, where they are subjected to the searching investigation demanded by their exotic origin. Its results are scarcely what might have been expected. Meteorites are not peculiar chemically; they consist exclusively of the same elementary substances composing the crust of the earth; but their mineralogy is highly distinctive. They are extremely complex structures, formed, apparently, in the absence of water, and with a short supply of oxygen; the further condition of powerful pressure is indicated with some probability, nay, with virtual certainty for those including small diamonds;* while prolonged vicissitudes of fracture and re-agglomeration are possibly recorded by the brecciated texture of many of these rocky *trouvailles*. Their aspect is thus anything but primitive; each fragment tacitly lays claim to an eventful history; they suggest a cataclysm, of which we behold in them the shattered outcome. The nature of such cataclysms is scarcely open to conjecture; only a hint regarding it may be gathered from the circumstance that the most profound terrestrial formations are those which approximate most closely to the mineralogical characteristics of meteorites.

Nevertheless, their only ascertained relationships are with comets. In every system of shooting stars the primary body most probably is, or at any rate was, a comet. Each appears to be the offspring of a cometary parent, and develops in the proportion of its decay. The view has hence been adopted, and not without justification, that comets in their primitive integrity are simply "meteor-swarms." Assent may be given to it with some qualifications which we need not here stop to discuss. What immediately concerns us is the interesting question as to the constitution of meteor-swarms. What is the real meaning of the term? What does it convey to our minds? A meteor-swarm may be defined as a rudely globular aggregation of small cosmical masses, revolving, under the influence of their mutual attraction, round their common centre of gravity. Each must revolve on its own account, though all have the same period; and their orbits may be inclined at all possible angles to a given plane, and may be traversed indifferently in either direction. From this tumultuous mode of circulation collisions should frequently ensue; but they would be of a mild character. They could not be otherwise in a system of insignificant mass, and correspondingly sluggish motion. We are considering, it must be remembered, only cometary swarms, as being the only collections of the sort that come, even remotely, within our ken; and comets include the minimum of matter. None of those hitherto observed, at least, whether conspicuous or obscure, newly arrived from space, or obviously effete, have occasioned the slightest gravitational disturbance to any member of our system.

Eventually, a cometary swarm, if left to itself, would probably take something of a Saturnian shape. Colliding particles would, owing to their loss of velocity, subside towards the centre, and accrete into a globular mass. A predominant current of movement would, through their elimination, gain more and more completely the upper hand; and it would finally, with the inevitable diminution of energy,† be restricted almost wholly to the principal

* For former articles under this title see KNOWLEDGE, 1903, pp. 57, 104, 148, 196, 251.

† *The New Astronomy*, p. 197.

* Carbon does not liquefy under ordinary conditions. In the production of his artificial diamonds, M. Moissan employed tremendous pressure and great heat; but the genuineness of his products has lately been denied.—Combes, *Moniteur Scientifique*, November, 1903.

† Sir R. Ball, "The Earth's Beginning," p. 243.

plane of the system, which would thus consist of a rotating nucleus encompassed by a wide zone of independently circulating meteorites. But this mode of development is not even approximately followed by comets. It would be possible only if they were isolated in space, and, in point of fact, their revolutions round the sun are of overwhelming importance to their destinies. The sun's repulsive energy causes them to waste and diffuse with expansion of splendid plumage. Under the sun's unequal attraction at close quarters they are subject to disruption, and the upshot of the tidal stresses acting upon them is the dispersal of their constituent particles along the wide ambit of their oval tracks.

We are, however, invited to look further afield. Cometary meteor-swarms may be only miniature specimens of the contents of space. Why should not remote sidereal regions be thronged with similar assemblages, colossal in their proportions, countless in number? And may they not supply the long-sought desideratum of a suitable "world-stuff" for the construction of suns and planets? From some such initial considerations as these, Sir Norman Lockyer developed, in 1887, an universal Meteoritic Hypothesis, designed on the widest possible lines, based on promising evidence, and professing to supply a key to the baffling enigma of cosmical growth and diversification. The meteoric affinities of comets formed its starting point; comets were assimilated to nebulæ; and from nebulæ were derived, by gradual processes of change, all the species of suns accessible to observation. The view was of far-reaching import and magnificent generality, but its value avowedly rested on a marshalled collection of facts of a special kind. In this it differed from the crowd of ambitious speculations regarding the origin of things by which it had been preceded. In this, it attained an immeasurable superiority over them, if only the testimony appealed to could be proved valid. Indeed, it is scarcely too much to say that, whether it were valid or not, the mere circumstance of having called the spectroscope as a witness in the high court of Cosmogony constituted an innovation both meritorious and significant.

The spectrum of the nebulæ was a standing puzzle. A theory which set out by making its meaning plain secured at once a privileged position. This was seemingly accomplished by Sir Norman Lockyer through the means of some simple laboratory experiments on the spectra of meteorites. Certain "low temperature" lines of magnetism given out by the vapours of stony aerolotic fragments were shown to fall suspiciously close to the chief nebular lines previously classed as "unknown." The coincidences, it is true, were determined with low dispersion, and were published for what they were worth; but they looked hopeful. Their substantiation, had it been possible, would have marked the beginning of a new stadium of progress. Nature, however, proved recalcitrant. The suggested agreements avowed themselves, on closer enquiry, as approximate only; magnesium-light makes no part of the nebular glow, and nebulium, its main source, evades terrestrial recognition. The light of cosmic clouds is, in fact, *sui generis*; it includes no metallic emissions; while the fundamental constituents of meteorites are metals variously assorted and combined.

The decipherment of the nebular hieroglyphics was the crucial test; its failure to meet it left the hypothesis seriously discredited; for coincidences between spectral rays common to nearly all the heavenly bodies naturally counted for nothing. Yet the investigation had its uses. The energy with which it was prosecuted, the ingenuity and resource with which it was directed, told for progress. There has been a clash of arms and a reorganisation of forces. Thought was stirred, observation and experiment received a strong stimulus, fresh affluents to the great stream of science began to be navigated. Efforts to prove what had been asserted were fruitful in some directions, and the work of refutation had inestimable value in defining what was admissible, and establishing unmistakable landmarks in astrophysics.

The discussion, however, threw very little light on the part played by meteorites in Cosmogony. Their world-building function remains largely speculative. Doubts of many kinds qualify its possibility, and lend it a fantastic air of unreality. But this may in part be due to a defect of imaginative power with which the universe is not concerned.

Waiving, then, preliminary objections, we find ourselves confronted with the essential question: Given a meteor-swarm of the requisite mass and dimensions, is there any chance of its condensing into a planetary system? Sir Norman Lockyer set aside this branch of his subject. His hypothesis was in fact "pre-nebular." He assumed that the small solid bodies with which it started would, in course of time, become completely volatilised by the heat of their mutual impacts, and that the resulting gaseous mass would thenceforward comport itself after the fashion prescribed by Laplace. Professor Darwin regarded the matter otherwise. It seemed to him possible to combine the postulates of the meteoric and nebular theories in a system planned on an original principle. For this purpose it was necessary to excogitate a means of rendering the kinetic theory of gases available for a meteor-swarm. "The very essence," he wrote,* "of the nebular hypothesis is the conception of fluid pressure, since without it the idea of a figure of equilibrium becomes inapplicable." M. Faye abandoned this idea; he built up his planets out of incoherent materials, thereby avoiding the incongruities, but forfeiting the logical precision, of Laplace's stricter procedure. Prof. Darwin consented to forfeit nothing; he stood forward as a syncretist, his object being to "point out that by a certain interpretation of the meteoric theory we may obtain a reconciliation of these two orders of ideas, and may hold that the origin of stellar and planetary systems is meteoric, whilst retaining the conception of fluid pressure." For the compassing of this end, he adopted a bold expedient. Fluid pressure in a gas is "the average result of the impacts of molecules." Fluid pressure in a meteor-swarm might, he conceived, be the net product of innumerable collisions between bodies to be regarded as molecules on an enormously magnified scale. The supposition is, indeed, as Kepler said of the distances of the fixed stars, "a big pill to swallow." From molecules to meteorites is a long leap in the dark. The machinery of gaseous impacts is obscure. It can be set in motion only by ascribing to the particles concerned properties of a most enigmatical character. These particles are, however, unthinkably minute; and in sub-sensible regions of research, the responsibilities of reason somehow become relaxed. We are far more critical as to the behaviour of gross, palpable matter, because experience can there be consulted, and is not unlikely to interpose its veto. Meteorites are doubtless totally dissimilar from molecules, however many million-fold enlarged; and they would infallibly be shattered by collisions which only serve to elicit from molecules their distinctive vibrations. Moreover, the advance of the shattering process would admittedly end the prevalence of fluid pressure. So that the desired condition, even if initially attained, would be transitory. There is, besides, a radical difference between a group of bodies in orbital circulation and a collection of particles moving at hap-hazard, unconstrained by any

* *Proceedings of the Royal Society*, Vol. XLV., p. 4.

predominant law of force. Professor Darwin's paper thus stands out as a monument of ingenious mathematical treatment applied to an ideal state of things.

An aggregation of revolving meteorites has no figure of equilibrium; and it is through the consequences necessarily resulting from this property that mathematicians are enabled to trace the progressive changes of a rotating fluid mass. In the absence of any such direct means of attack, their position regarding the problem presented by an assemblage of flying stones is not much better than that occupied by Kant, face to face with an evolving universe. It seems, however, clear that a meteor-swarm can condense only through the effects of collisions among its constituents. When the irregularities of movement upon which their occurrence depends are got rid of, the system must remain *in statu quo*. Order makes for permanence; a tumultuary condition is transient. The eventual state of the system can, however, be no more than partially foreseen. Bodies arrested in their flight should fall inward; hence a central mass would form and grow; but the production of planets would seem to be conditional upon the existence of primitive inequalities of density in the swarm. These might serve as nuclei of attraction for meteoric infalls, not yet completely exhausted, but plying with harmless fire one at least of the globes they helped to shape. There could, indeed, on this showing, have been no such harmonious succession of events as constituted the predominant charm of Laplace's scheme. The planets should be supposed to have issued pell-mell out of a chaos; or, rather, the chaos should have contained from the beginning the seeds of a predestined cosmos. Its evolution would have been like that of the oak from the acorn, an unfolding of what was already essentially there. And it may be that at this stage of penetration into the past, the unaided human intellect meets its *ne plus ultra*. There is a vital heart of things which we cannot hope to reach. Thought instinctively pauses before the vision of the symbolical brooding Dove.

To resume. Meteoric cosmogony deserves serious consideration. Materials for the purpose probably exist abundantly; and, in the solar system at least, they must have been formerly much more abundant than they now are. The earth has been raking up meteoric granules by hundreds of millions daily during untold ages, and her zone of space is still very far from being swept clean. The persistence of the supply, however, may be occasioned by the continual arrival of reinforcements from interstellar realms. Comets appertain to, and travel with the sun's cortège; and this is also inevitably true of comet-born meteors. But a multitude besides circulate independently of comets, and with much higher velocities. Their orbits are then hyperbolic: they belong to the category of "irrevocable travellers," and their capture provides us with genuine samples of sidereal matter. Universal space must contain them in vast numbers, yet there is nothing to prove their collection into swarms. The spectroscope supplies no assurance to that effect; it has given its verdict against the meteoric constitution of nebulæ and temporary stars. And if we admit, under the compulsion of mineralogical testimony, that the aerolites so strangely landed on terrestrial soil are really the *débris* of ruined worlds, we can see for them no chance of restoration. Solitary they are, even if they occasionally pursue one another along an identical track, and solitary they must remain. Bodies do not of themselves initiate mutual circulation. Planetary or stellar outcasts cannot become re-associated into a gravitational system. Of a cosmic swarm, as of a poet, it may be said, *Nascitur, non fit*; and their birth-secret is undivulged.

JUPITER AND HIS SURFACE CURRENTS.

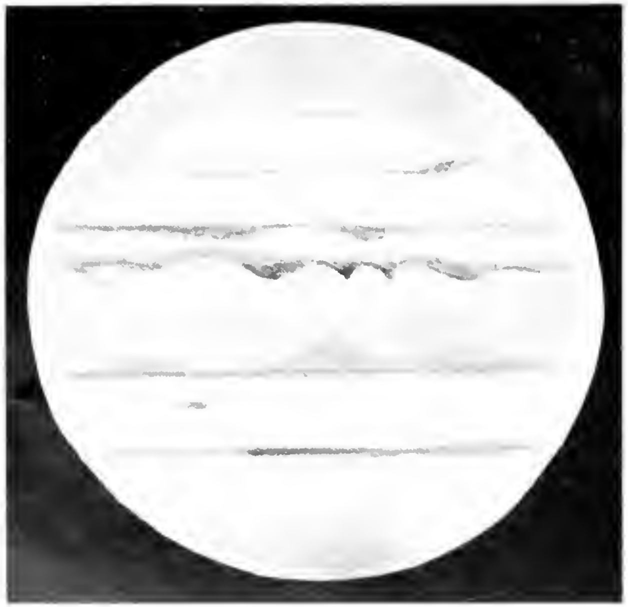
By the Rev. T. E. R. Phillips, M.A., F.R.A.S.

The general aspect in the telescope of the planet Jupiter is well known. His markedly elliptical disc, which is distinctly brighter in the centre and gradually fades off towards the limb, is traversed by a series of dusky belts which vary from time to time both in width and position. These belts frequently show great irregularities at the edges, being broken up or indented by a number of light and dark spots, while dusky wisps are often to be seen projecting from them across the bright zones which separate them. The accompanying drawings will serve to illustrate the general arrangement of the surface features and also the great and rapid changes of aspect to which they are subject. Thus it will be seen from the illustrations that in the years 1896 and 1898 (Figs. 1 and 3)—as was also the case in 1901 and 1903—the belt lying North of the equator was quite narrow, but that at other times it was broad, and exhibited numerous condensations and white spots at its edges. It not infrequently happens that the general aspect of the planet undergoes a marked alteration even in the course of a single apparition. Thus Fig. 6 represents a view of Jupiter in June, 1902, but by the latter part of the autumn the appearance of the disc had materially changed. The equatorial regions were intensely white—a very striking contrast to the rich warm coppery tone which was so marked a feature of the planet a few years ago—and the whole of the disc North of the N. temperate belt was deeply shaded with a delicate bluish grey.

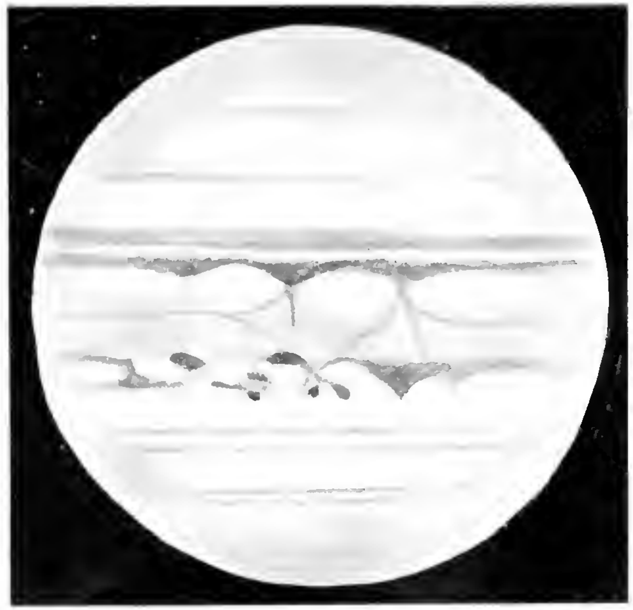
It is probable that some of the changes on Jupiter are of a cyclical or seasonal character. Mr. A. Stanley Williams in a valuable paper communicated to the Royal Astronomical Society in April, 1899, showed from a discussion of a large number of observations extending over many years that there is a remarkable variation in the colour of the two principal equatorial belts. Thus, when the S. equatorial belt is at a maximum of redness, the N. equatorial belt is at a minimum, or even bluish in tone, and *vice versâ*. The mean period of these variations is found to be about twelve years, and as this corresponds with the length of a sidereal revolution of Jupiter round the sun, it is probable that the change observed is of a seasonal character. The maximum redness occurs soon after the vernal equinox of the particular hemisphere in which the belt exhibiting it is situated. In accordance with the interesting conclusion at which Mr. Williams has arrived, the N. equatorial belt has lately been intensely red, and the S. equatorial belt almost colourless, except in the region immediately following the Red Spot bay.

But, perhaps, the most interesting and instructive feature hitherto observed in connection with Jupiter is the difference of speed with which his spots and other markings are drifting. So long ago as the latter part of the 17th century, Cassini found that the markings in the neighbourhood of the equator performed a rotation in nearly six minutes less time than was required by objects further north and south. Sir William Herschel, Schröter, and other observers confirmed this result, but as the outcome of the labours of more modern investigators, a considerable number of distinct currents are now known to control the movements of Jupiter's surface material. There can be no doubt that many recorded changes on Jupiter are in reality due to the great proper motions of the objects observed, which quickly cause them to become relatively displaced.

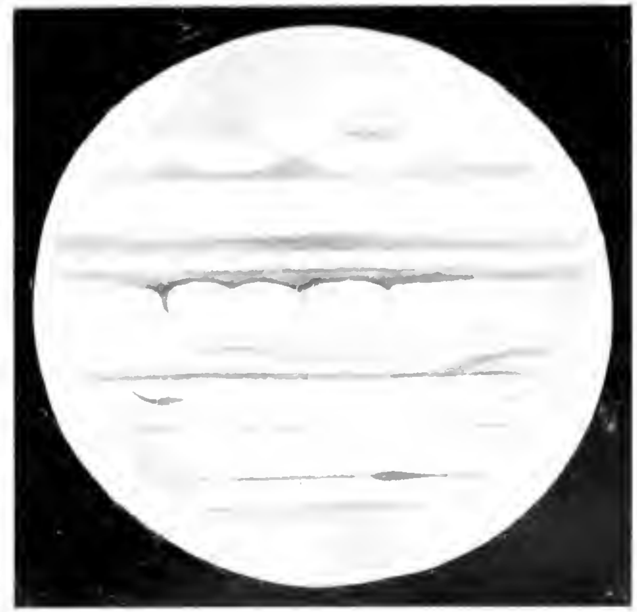
JUPITER.



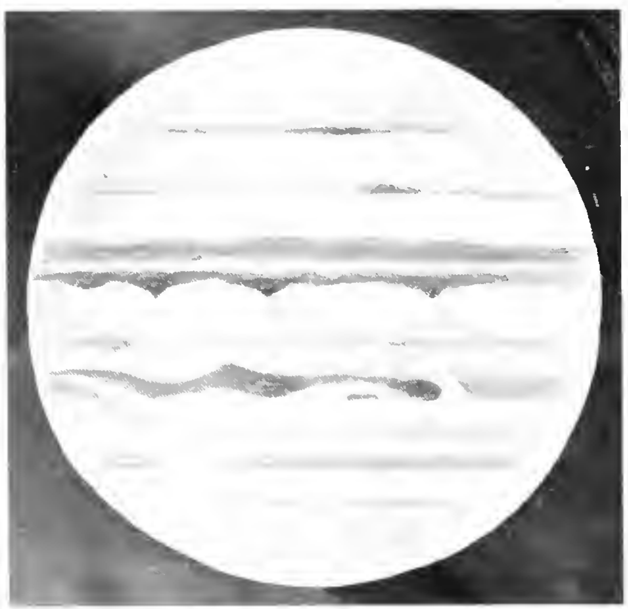
1896, March, 2d. 6h. 30m. G.M.T.



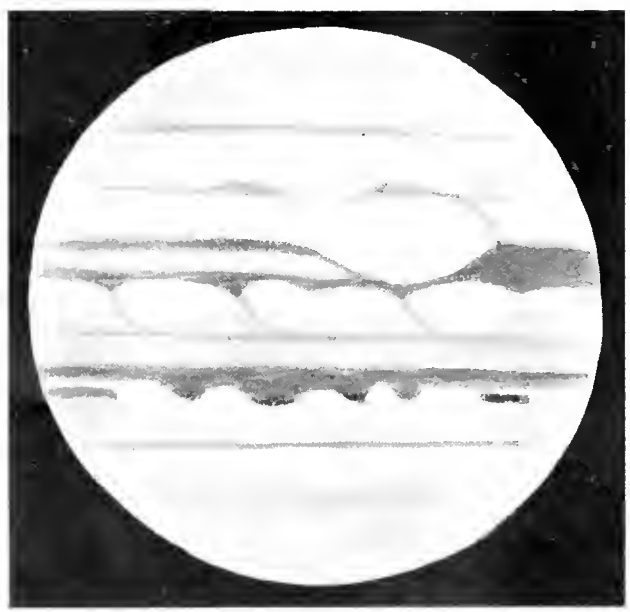
1897, March, 9d. 11h. 55m. G.M.T.



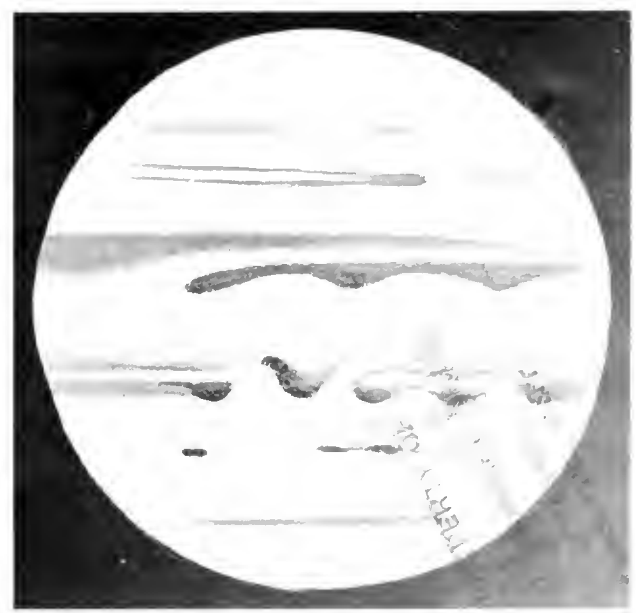
1898, April, 4d. 9h. 55m. G.M.T.



1899, April, 15d. 12h. 10m. G.M.T.



1900, April, 20d. 14h. 15m. G.M.T.



1902, June, 26d. 14h. 31m. G.M.T.

With one or two exceptions these surface currents are pretty constant. Their velocity varies within certain limits, and the latitude of their boundaries is not always the same, but whenever definite spots or observable condensations appear their movements of rotation are nearly always found to conform more or less closely to the normal speed of that latitude. In an article in the February, 1903, number of *Popular Astronomy*, Prof. G. W. Hough questions the existence of several of these surface currents. Considering, however, the great mass of existing evidence, I venture to think that his conclusion is altogether unfounded, and that the reality of the currents is beyond dispute. In January, 1896, a valuable paper by Mr. A. S. Williams was published in the *Monthly Notices*, R. A. S., "On the Drift of the Surface Material of Jupiter in Different Latitudes." In that paper Mr Williams brought together the results of numerous eminent observers in various years, and gave a clear account of nine separate and distinct currents. It is worthy of note that the arrangement of these currents, unlike those of the sun, is by no means symmetrical, neither is that of the two hemispheres the same. Moreover, the N. hemisphere contains in contiguity the swiftest and the slowest that have yet been observed.

The following table shows the general arrangement of these surface currents, but it must be understood that both the limiting latitudes and the rotation periods are subject to certain variations:—

No.	Latitude	Rotation Period.	Remarks.
		h. m. s.	
1	+80° to +38°	9 55 37.5	From Polar Regions to N. N. Temp. belt.
2	+38° to +24°	9 54 30 / 9 56 30	From N. N. Temp. belt to N. component of N. Temp. belt.
3	+24° to +20°	9 48 [illegible] / 9 49 [illegible]	S. component of N. Temp. belt.
4	+20° to +10°	9 55 32	N. Trop. zone and N. side of N. Equatorial belt.
5	+10° to −12°	9 50 20	Great Equatorial Current comprising S. portion of N. Equatorial belt, Equatorial zone, and N. component of S. Equatorial belt.
6	−12° to −14°	9 51 30	Spots on bright rift dividing S. Equatorial belt.
7	−12° to −18°	9 55 40	S. component of S. Equatorial belt.
8	−14° to −25°	9 55 37	Great Red Spot.
9	−18° to −35°	9 55 18.5	From S. Tropical zone to S. Temp. zone.
10	−36° to −57°	9 55 6	S. S. Temp. belt and bright zones S. of it.
11	−57° ±	9 55 23	Faint S. Polar shading.

These currents must be discussed more in detail.

No. 1.—There appears to be some uncertainty as to how far north this current extends. In 1888 and again in 1892, Mr. Williams observed dark streaks which extended into very high N. latitudes and moved in accordance with the tabulated velocity. Since then Captain P. B. Molesworth, who has made quite a unique series of Jovian observations under very fine seeing conditions in Ceylon, has succeeded in detecting a number of light and dark spots and streaks in the Polar regions. Amongst these, he found in 1901 five dusky streaks in about latitude 50°, which gave a mean period of 9h. 56m. 3.7s. It is quite probable that the surface drift in these regions may be variable from year to year. More observations are much needed to settle the question of the minor, and at present doubtful, currents on the surface of Jupiter.

No. 2.—The drift in this region is not constant. At times when the N. hemisphere is in a state of disturbance spots are liable to appear which have a decidedly rapid rate of motion. As a general rule, however, it is found that markings in this neighbourhood exhibit the slowest movement of any on the disc.

No. 3.—This is unquestionably the most remarkable, as it is the swiftest, of all the Jovian currents. Our knowledge of it has been well summarised by Mr. W. F. Denning in a paper entitled "On a Probable Increase of Periodically Recurrent Disturbance on the Surface of Jupiter," published in *Monthly Notices*, R. A. S., December, 1898. It appears that at intervals of little more than ten years spots have frequently appeared on the S. side of the N. temperate belt which have exhibited a velocity which is extraordinary. As already pointed out, this swift current exists side by side with the slowest of the disc (No. 2), and taking their extreme values the difference of velocity amounts to about 365 miles per hour. It was thought that another outbreak of these rapidly-moving spots would occur at the end of 1900 or beginning of 1901. Unfortunately no such occurrence was observed, but it is quite possible that spots may have appeared and escaped detection, as in December, 1900, the planet was in conjunction with the sun.

No. 4.—This, commonly known as the N. Tropical Current, is another of the most important of the Jovian currents, and is generally in evidence. In some years when the N. equatorial belt is narrow, a number of dark spots are seen quite detached from this belt (*see* Figs. 1 and 3), and in 1898 and 1903 these were connected by a fine narrow line like beads strung on a thread. This narrow line is shown in Fig. 3 starting from one of these spots. On other occasions the N. equatorial belt extends so far north as to include this region, but it is found that the spots at its edge, which are often very numerous and definite, conform to the normal velocity of the N. Tropical Current, even though the S. edge of the belt be drifting at the same rate as the equatorial zone. I have given 9h. 55m. 32s. as the rotation period of this region, but it frequently happens that spots exhibit a period very considerably longer than this, and also very considerably shorter. A remarkable diversity of speed was apparent in this current in 1899. In that year I received a large number of transit observations of N. tropical spots from several observers, so that an ample amount of material was available for discussion. I had previously found from observations secured comparatively early in the apparition that a dark spot (shown in Fig. 4) lying in a distinct bay on the N. side of the N. equatorial belt—was moving at an altogether abnormal rate, but when the whole of the materials to hand were charted and examined, it was found that the spots between longitudes 140° and 260° had a mean rotation period of 18.5 seconds less than that of the remainder of the current. The exact values were 9h. 55m. 15.4s. and 9h. 55m. 33.9s. respectively. So far as I am aware so rapid a drift as that indicated by the former value has never been observed in this latitude before. Further, it was noticed that the limits of longitude which included this swift rotation were constant during the period covered by the observations. Spots starting from λ 260° quickly hurried forward, and rapidly-moving spots on reaching λ 140° suddenly slowed down. A full account of this remarkable disturbance will be found in my paper on "The Extra-Equatorial Currents of Jupiter in 1899," published in *Monthly Notices*, R. A. S., January, 1900.

No. 5.—We now come to the Great Equatorial Current. The northern boundary of this current is variable. When narrow, the whole of the N. equatorial belt appears to be included within its limits, but at other times only the southern component, or possibly the whole of the belt may lie without it. At any rate, spots near the N. limit of the zone frequently exhibit a period a few seconds longer than those at or near the N. edge of the S. equatorial belt. It is to these latter that most of the determinations of velocity in previous years refer. It is worth noticing

that in 1879 the period was only about 9h. 50m., but subsequently, increased steadily to 9h. 50m. 36s. in 1896. Since then the value has again declined, a sudden drop having been followed by somewhat irregular variations.

The following are the periods which I have found from a discussion of my own observations during the past few years :—

Year.		Number of Spots observed.		Rotation Period. h.	m.	s.
1898	...	19	...	9	50	24·2
1899	...	34	...	9	50	24·7
1900	...	26	...	9	50	23·7
1901	...	24	...	9	50	28·6
1902	...	24	...	9	50	27·8

A remarkable feature of the Great Equatorial Current is found in the peculiar wanderings or oscillations of the spots on each side of their mean or computed positions; and it frequently happens that a whole group of spots will share these vagaries of motion together. Despite these wanderings, however, there can be no doubt that many of the equatorial spots remain visible for long periods of time, but the fact that the planet is lost in the sun's rays, so far as satisfactory observations are concerned, for at least three months about the time of his conjunction—to say nothing of the difficulties caused by irregularities of motion and changes of form in the spots themselves—make their correct identification from year to year almost impossible.

No. 6.—A bright rift is usually seen to divide the S. equatorial belt into two separate components. During the last few years Captain Molesworth has followed a large number of bright spots in this rift, which appears to form a kind of transition stage between the two well-known periods of 9h. 50m. + and 9h. 55m. +. His rates for 1900 and 1901 are 9h. 51m. 37·3s. (from 17 spots) and 9h. 51m. 32·2s. (from 20 spots) respectively.

No. 7.—On the occasions when markings on the S. component of the S. equatorial belt have been observed and followed, it has been found that their period differs but little from the contemporary period of the Great Red Spot.

No. 8.—This can scarcely be called a current, as the surface material referred to under this heading is confined within the limits of the Great Red Spot. This remarkable object was detected in 1878 by M. O. Lohse, of Potsdam (who appears to have been the first to draw it), and by Professor Pritchett, of Missouri, and Mr. Dennett, of Southampton (whose observations seem to have been the earliest published), and quickly attracted general notice. Nearly every telescope was directed to its observation, and its behaviour carefully watched. It is elliptical in shape; its dimensions being about 27,000 miles in length, and nearly 9000 in breadth. What the nature of the spot may be it is impossible at present to say. Certainly it cannot be regarded as a solid feature of the planet's globe, since it is by no means stable in position; but, on the other hand, there can be no doubt that it is the product of forces which have considerable permanence, and, judging from the very definite and regular appearance of the well-known hollow or bay on the S. side of the S. equatorial belt in which the Red Spot lies (*see* Fig. 5), despite the present faintness of the spot itself, as yet show no signs of declining energy. A very interesting account of the early history of the Red Spot will be found in two valuable papers by Mr. Denning in the supplementary numbers of *Monthly Notices*, R. A. S., 1898 and 1899, and also in his article in this journal for August, 1902. In these papers Mr. Denning connects the present spot and hollow in which it lies with the ellipse seen by Mr. Gledhill in 1869, and with numerous similar objects which have appeared in the southern hemisphere at intervals since 1831. Indeed it is quite possible that the Red Spot of to-day may be identical with the remarkable object discovered by Dr. Hooke, so long ago as 1664. The determinations of the rotation period have been very numerous. Mr Denning, from a careful examination of existing material, and assuming his identifications to be correct, finds that in 1831 the period was 9h. 55m. 33·3s., that it increased to 9h. 55m. 38·3s. in 1859, again declined to 9h. 55m. 33·4s. in 1877, and once again increased to 9h. 55m. 41·9s. in 1899. In 1900 the rotational velocity exhibited a slight increase; in 1901 the spot remained almost stationary in longitude (as based on the period of 9h. 55m. 40·63s., adopted by Messrs. Marth and Crommelin as the value of their zero meridian of System II.); and in 1902—from a discussion of about 100 transit observations of the spot and hollow secured by various observers—I find the period of the object to have been reduced to 9h. 55m. 39·3s. It should be added that the spot, in addition to its oscillations in longitude, like so many of the markings on the planet, has also a motion in latitude—the extreme drift being about 4000 miles. The deep red tone which distinguished the spot at the time of its appearance in 1878 soon proved evanescent, and the object is now but a ghost of its former self. In some years it has appeared merely as a faint elliptical ring; at others, the whole has just been visible as a feeble dusky stain on the bright zone in which it lies. Possibly it may be dimmed by the overlying vapours, but, as already stated, there is no reason to suppose that the forces which produce it are on the wane, and we may yet hope that at some future time it will reassume its former glory.

No. 9.—This is unquestionably the steadiest and most uniform of all the Jovian currents. It was detected by Schröter so long ago as 1787, since which time it has shown practically no variation. It extends over quite a broad zone, embracing the region between the S. edge of the S. equatorial belt, and the N. edge of the S.S. temperate belt. Observers of Jupiter will remember the remarkable S. tropical mass of dark material—extending eventually over about 90° of longitude—which swept round the S. side of the Red Spot during the summer of 1902.

No. 10.—This rapid current so far south is remarkable. It appears to be fairly constant and uniform, but has nothing in a similar latitude to correspond with it in the northern hemisphere.

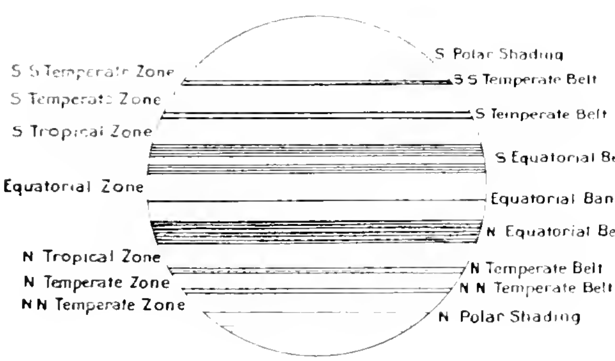
No. 11.—In 1901 Captain Molesworth detected a number of dark objects at the edge of the N. polar shading. These did not share in the rapid drift of the Great Southern Current (No. 10), but moved approximately at the tabulated rate. More observations are needed to establish the constancy of this current.

But interesting as is the investigation of these surface currents, the real nature of Jupiter's physical condition is the problem which students of the planet must endeavour to solve. It has generally been agreed that the belts and spots of Jupiter are of the nature of clouds and atmospheric vapours, that the true globe of the planet has never been seen; and that its real rotation period is consequently unknown. But whatever view may be adopted as to the vaporous character or otherwise of the visible features of the disc, it is probable that the internal body of the planet rotates in a period somewhat longer than any markings we can observe—possibly in a period just a minute or so less than 10 hours. As regards the relative altitudes of the various markings, there seems good reason to suppose that the more swiftly moving objects are situated at a greater height than those which move more slowly. Of course, it must be remembered that the planet may have no solid or definite surface divided off from the vapours which form its belts and spots. It is highly probable—bearing in

mind the very low density of Jupiter that the whole globe is still in an intensely heated, semi-molten and viscous condition, and that what we see is but the outermost shell of visible material. Professor Hough, in his important and valuable paper already referred to, suggests that the visible boundary of Jupiter has a density of about one-half that of water, is of the nature of a liquid, and that in it are immersed the Red Spot and others whose motion in longitude and latitude are slow and gradual, and which are tolerably permanent or long enduring. He considers that the equatorial and other belts may be at the surface of this liquid or at a higher level than the Red Spot, and that the equatorial regions may be concealed by overlying vapours at a much greater altitude, in which openings and irregular condensations give rise to the appearance of white and dark spots.

No doubt there are many interesting questions in connection with Jupiter of which the solution must be left for future students; but this much, at any rate, we may suggest with some confidence:—We look at Mars and our own satellite, in them we see a forecast of physical conditions to which some day the earth must at least approximately attain. We look at Jupiter, and, in the constant agitation of his heated globe, we catch a glimpse, though on a giant scale, of our own world in the dim recesses of the past.

The accompanying diagram will enable the reader to



identify the various features referred to in the above article and depicted in the illustrations.

THE SHOWER OF LEONID METEORS IN 1903.

By W. F. DENNING, F.R.A.S.

TEMPEL'S comet (1866 I.) and the dense swarm of meteors in its contiguous region having passed through perihelion unobserved in 1899 the prospect of a fine shower of Leonids in 1903 appeared very doubtful. The meteors being, however, pretty thickly distributed along a considerable extent of the orbit, a fairly active recurrence of the shower was thought to be quite possible. Those observers who watched for its return on the morning of November 16 realised their best expectations. The Leonids were abundantly presented, offering the best meteoric spectacle observed in England since 1885, and forming the prototype, if far from being the parallel, of the grand exhibitions of 1799, 1833 and 1866.

The following are brief extracts from observations on the night following November 15, which have either been published or privately communicated to the writer:—

Backhouse, T. W., Sunderland.—Between 17h. 11m. and 18h. 5m., about 83 meteors per hour. A Leonid fireball seen at 15h. 49m. The Leonids were bright generally. Of 65 recorded, 1 [illegible] Venus, [illegible] and 26 brighter than or equal to [illegible]

Brook, C. L., M [illegible], Huddersfield. [illegible] and 15h. 30m., 32 Leonids were seen, [illegible] interfered. Very brilliant Leonid at 15h. [illegible] shot from 137° + 8° to 153° + 0°. Radiant at 150° + 23°.

Corder, H., Bridgwater.—Between 17h. and 18h., about 200 meteors per hour. Estimated position of radiant, 149° + 22°.

Crace, W. J., Exeter.—Between 16h. 25m. and 17h. 10m. 108 meteors observed.

Denning, W. F., Bristol.—The display watched between 12h. and 18h. 15m. Maximum, 17h. 30m. to 17h. 45m. 42 meteors. Radiant, 151° + 22°, about 6 degrees in diameter.

Ellison, Rev. W. F. A., Enniscorthy.—11h. 45m. to 12h. 45m., 5 Leonids; 12h. 45m. to 13h. 45m., 16 Leonids; 13h. 45m. to 14h. 45m., 36 Leonids; 14h. 45m. to 15h., 11 Leonids; 15h. to 15h. 15m., 0 Leonids! Three fireballs seen. 13h. 40m., 153° + 43° to 185° + 28° (Taurid); 13h. 58m., 160° + 18° to 166° + 12° (Leonid); and 14h. 19m., 240° + 65° to 273° + 58° (Leonid).

Royal Observatory, Greenwich.—About 150 meteors seen, some as bright as Venus, the most prolific time being about 18h., when they appeared at the rate of 100 per hour.

Henry, J. R., Dublin.—15 Leonids seen in 15 minutes preceding 15h., and 20 in 15 minutes following that hour. Between 16h. and 17h. 30m. observer had the impression that meteors were appearing at the rate of from 200 to 300 per hour.

Herschel, Prof. A. S., Slough.—Not much short of 200-250 meteors per hour. Brilliant Venus-like meteors observed at 16h. 34m., 17h. 33m., and 17h. 41m.

Horner, Misses, Taplow.—During last hour of darkness counted 86 meteors, nearly all of which were Leonids.

Johnson, Rev. S. J., Bridport.—Several hundreds of meteors with the usual Leonid streaks and swift motions must have passed across the whole sky. 16h. 27m., Leonid equal to Venus, 192° + 13° to 195° + 10°.

Knight, G. M., London.—November 14–17, 217 Leonids registered at Hampstead. Five fireballs seen with streaks, indicating radiant at 149½° + 23°. Maximum 17h. 30m., November 15.

King, A., Sheffield.—17h. 57m. to 18h. 3m., 18 Leonids. Hourly rate, about 200. Radiant, 148° + 22°.

Milligan, W. H., County Down.—Apparent maximum, 14h. to 16h., with horary rate of 80 to 100 for one observer. Radiant, 149° + 22°.

McHarg, John, Lisburn.—13h. 20m. to 14h. 20m., 20 Leonids, large proportion 1st magnitude; 13h. 15m., vivid green fireball from Taurus, 103° + 0° to 112° − 6°.

Moffat, A. G., Swansea.—16h. 30m. to 18h., a brilliant display of large meteors; some green-coloured, the major portion, however, electric blue.

Service, R., Dumfries.—18h. 30m. to 19h., 12 Leonids observed.

Thompson, G. C., Cardiff.—Watching with a friend for several hours, only about 25 Leonids were seen; a number of other meteors radiated from Auriga.

Wright, F. H., Northampton.—15h. to 15h. 30m., 30 meteors; 15h. 30m. to 16h., 60 meteors; afterwards counted at rate 3 or 4 per minute. Maximum at about 17h. 15m., near which time 8 or 10 were several times counted in one minute, and 5 or 6 visible in the sky at the same instant.

The general results may be summarized as follows:—

Time of maximum, November 15, 17h. 40m.

Rate of apparition, 4 per minute for one observer.

Point of radiation, 150° + 22°.
Character of meteors, bright generally, with streaks and swift motions.

Several Leonids and meteors belonging to contemporary minor showers were doubly observed, and their real paths have been computed. Among the latter there was a Taurid fireball seen on November 15, about 13h. 42m., at Enniscorthy and Leicester. It passed over the S.E. part of Anglesey at heights from 72 to 32 miles, with a velocity of 23 miles per second. Radiant at 61° + 24°. A 2nd magnitude meteor appeared on November 15, 15h. 59m., directed from a radiant at 113° + 31°, and descending from 64 to 48 miles along an extended course of about 142 miles from over Sussex to Lincoln. Velocity about 19 miles per second, but the flight of the meteor seemed much retarded by atmospheric resistance, and at the end of its visible career, as observed at Bristol, it became almost stationary, its material and momentum being apparently quite exhausted.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

LARGE *VERSUS* SMALL TELESCOPES IN PLANETARY WORK.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In the course of his interesting article on Saturn in the current number of KNOWLEDGE, Mr. W. F. Denning has referred to the well-known fact of large telescopes sometimes failing to show faint planetary markings that were visible in those of much smaller aperture. The markings in question usually appear to be those having a considerable apparent area and a more or less diffuse and indefinite outline, and I do not remember to have ever seen any demonstration, either theoretical or practical, why markings of this nature should be any plainer or better seen as a whole in a large telescope than in a small one. As regards *minute* details there can, however, be no question as to the superiority of the large telescope.

But my present object in writing is to draw attention to the fact that the remarkable and instructive experiments on artificial markings, details of which have been recently published, seem to have an intimate bearing also on this question of the failure of large telescopes to show planetary markings visible in smaller ones. Particulars of one of these experiments having a special bearing on the subject, made by Mr. and Mrs. Maunder, have been recently published in the *Journal* of the British Astronomical Association, Vol. XIII., page 349. In this experiment two waved parallel lines when viewed at a distance of 130 feet, gave rise to the appearance of a faint, diffused band. On approaching nearer, the experimenters found, to their evident surprise, that this appearance after awhile began to get feeble, and finally *disappeared altogether* at a distance of about 100 feet. Nothing could then be seen at the place of the two waved lines until approach had been made to very nearly 60 feet, when the lines rapidly became distinct.

Now the employment of a larger aperture, and probably higher power, would [illegible] be analogous in its effect to a diminution in the distance [illegible], and hence, even assuming all other things [illegible] it does not seem difficult to conceive the existence [illegible] particular kind of marking that would give rise to [illegible] impression in a small telescope, although nothing [illegible] could be seen at the same place with a large one. [illegible] a number of faint, irregular, narrow streaks crossing the bright equatorial zone of Saturn, perhaps analogous in their nature to the well-known equatorial "wisps" of Jupiter, and corresponding to the waved lines of the experiment, might give rise to an appearance of alternate faint and dark areas or spots in a small telescope, though a "giant" telescope might fail to show anything whatever of this appearance. Yet such apparent markings or spots, although not strictly objective, would clearly have an objective basis, and hence they would be suitable for determining the rotation period.

A. STANLEY WILLIAMS.

Hove, 1903, December 1.

THE ORCHID CEPHALANTHERA GRANDIFLORA.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I have long had a thing to say about the fertilization of *Cephalanthera grandiflora*, and now that Mr. Praeger's interesting article on Orchids has appeared I don't think I could fit it with a better time.

Figs. 1 and 2 represent respectively the front and side views of the column of this plant, and are drawn from life. What are the threads that cross and re-cross and attach themselves not only to the stigma but to the front of the column and sides of basal portion of labellum, like the supporting strands of a spider's web? If they are pollen

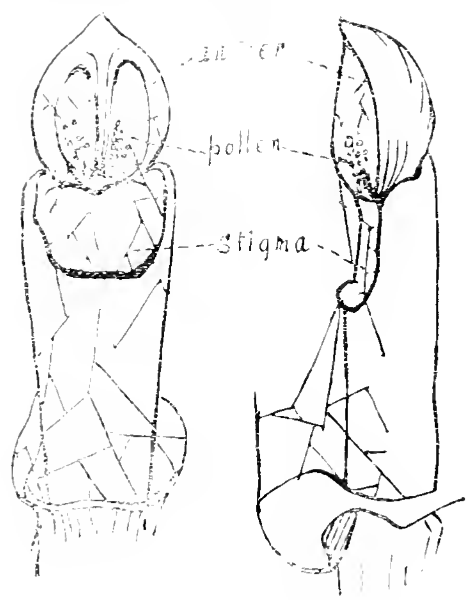


FIG. 1 FIG. 2.

tubes, why the curious reticulation? At first I thought the meshes were caused by pollen grains falling upon different parts of the column, whence they might germinate in any direction, but, in spite of Darwin, who says the grains "readily adhere to any object," I have tried to remove them at all stages of development and not one grain could I get away, not even with the hairy edge of a piece of blotting paper; now I am thinking that the earliest tubes as they elongate may drag out and carry down from the pollinia grains that may be later in germinating, and would thus add meshes to the net. How does my supposition stand? I should add that pollen masses almost entirely disappear when the threads are most numerous.

C. E. CLARK.

24, Iffley Road,
Hammersmith, W.,
November 16th, 1903.

A FOG BOW.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—I should like to know if any of your readers can explain a strange phenomenon which I saw whilst travelling to Brighton from Hastings by train, about 7 o'clock on the evening of the 30th of September last. The night was hazy, and looking through the open window I distinctly saw outlined against the sky a circle, or rather an oval-shaped bow enclosing a long cross, the lower part of the vision being veiled in mist, the tones were neutral and soft, though clearly defined. It disappeared from view suddenly, and though I watched for quite half-an-hour, it did not appear again. The train at this time was running through the flat marshy country, known, I believe, as Pevensey Level, therefore skirting the sea-shore. A picture of a similar appearance in Whymper's "Scrambles amongst the Alps," recalled the circumstance to me.

Beckley. MARY FRASER.

Obituary.

HERBERT SPENCER.

It is with deep regret that we record the death of Mr. Herbert Spencer, which occurred in the early morning of the 8th of December, at his house in Brighton.

The last survivor of the many eminent men of his time, Spencer enjoyed the unique distinction of completing the stupendous task he had set himself as the purpose of his life, a task which occupied him for the long period of thirty-six years (1860-1896). It is doubtful whether the history of letters contains a more remarkable instance of the amazing results of courage and tenacity than is found in the production of Spencer's Synthetic Philosophy. "How insane my project must have looked to onlookers," he says, when with his small resources frittered away, and his health permanently impaired by overtax of brain, he was obliged to desist by reason of nervous breakdown actually before the first chapter of the first volume was finished. But the philosopher afterwards pursued his course undeterred, and he completed it with the expression of the modest satisfaction that losses, discouragements, and shattered health had not prevented the fulfilment of his long task.

Born in Derby on the 27th April, 1820, the son of a teacher of mathematics, he shared with John Mill the distinction of having his education directed entirely at home, although in Spencer's case an uncle assisted the father. But he never had any experience of school or college, and he early abandoned his profession in order to devote himself entirely to speculative thought. Spencer's long career is singularly uneventful in personal history, and it is certainly by no desire of his that the world knew anything about him. But as a frequent contributor to the *Westminster Review*, in his earlier days, Spencer was brought into contact with many of its then brilliant writers, and his striking originality was displayed in association with Hamilton and the two Mills. From the year 1860, when the philosopher first resolved to concentrate himself upon his great project, Spencer's own life is little more than the story of the publication of the successive parts of his system of Philosophy, until that happy day in 1896, when he reached the close of his long labour, and found pleasure in his emancipation. He had the felicity to receive a congratulatory address from his contemporaries eminent in science, literature, and philosophy, and arising out of that address, Mr. Hubert Herkomer painted the well-known portrait which [illegible] exhibited [illegible] the [illegible] [illegible] to this address, Mr. [illegible] general feeling as [illegible] Spencer [illegible] I beg that you will, if you think proper, [illegible] approver of the request [illegible] Mr. Spencer, [illegible] abilities and, rarer still, whose mental and [illegible] character are so justly objects of admiration."

British Ornithological Notes.

Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

Bird Migration in Sutherland, by ROBERT SERVICE, M.B.O.U. (*Annals of Scot. Nat. Hist.*, 1903, pp. 193-201).—This is an interesting and distinctly valuable article of actual observations of bird-migration. Of the arrival of birds, such as Finches and Warblers, Mr. Service writes:—"[illegible] it requires the minutest attention to see the individual birds arrive one by one. They seem to drop literally from the clouds. Let one's attention be diverted for a moment, next time you look at a particular place there are one, or two, or three birds that were not on the spot last time you glanced at it." Of the call notes heard during the progress of a great migratory movement at night, he writes:—"There is not one of us but will be confounded and humiliated to find that a very large proportion of the sounds cannot be assigned to any known species with certainty. Of course, the explanation lies in the fact that birds when on migration use notes that are not required at other periods of their lives." Of the altitude at which birds migrate the writer states:—"Skylarks and Swallows are about the only birds I am acquainted with that migrate at a comparatively low level. Quite invariably other birds that I have seen actually starting on their long journey mount very quickly upwards in a slanting direction, till they reach a height at which they can only be recognized by some peculiarity of flight." There are many interesting observations in this paper. Mr. Service has not read, apparently, Mr. Eagle Clarke's valuable papers on the subject, and the records of his own actual observations have been uninfluenced, seemingly, by those of others.

Barred Warbler in Lincolnshire (*Zoologist*, 1903, p. 363).—In an account of the migration of birds in North-east Lincolnshire during the autumn of 1902, Mr. G. H. Caton Haigh records that he shot a young female of this Warbler at North Cotes on September 20th. This is, I believe, the third specimen of the Barred Warbler which Mr. Haigh has recorded, and the eighteenth or so which has occurred in the British Islands.

Sabine's Gull in Yorkshire (*Zoologist*, 1903, pp. 363, 391, 436).—The Rev. Julian G. Tuck has now recorded the occurrence of five (four adults) Sabine's Gulls in September and October last on the Yorkshire coast. This arctic species not infrequently visits our shores in autumn, but most of the previous records have referred to immature birds.

Rare Birds in Kent and Sussex (*Zoologist*, 1903, pp. 418-425).—Mr. N. F. Ticehurst here tabulates the remarkable number of rare birds which it has fallen to the lot of ornithologists in Sussex and Kent to record during the last twelve months. The most noteworthy of these have already been reported in these columns.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at the Office of* KNOWLEDGE, 326, *High Holborn, London.*

Notes.

ZOOLOGICAL.—According to recent information, the white [illegible] (*Rhinoceros simus*), at one time believed to be [illegible] extinct, appears to be comparatively common [illegible] frontier of the Congo Free State and the [illegible] of the Soudan.

The [illegible] anthropological and zoological [illegible] Messrs. Robinson and Annandale [illegible] the Malay Peninsula are to be described [illegible] *Fasciculi Malayenses*. The first part [illegible] account of Mammals, by Mr. J. L. Bonhote [illegible] been issued. Sixty [illegible] number of mammalian species included [illegible] eight are described as new.

Great interest attaches to the description by Dr. Max Schlosser, of Berlin, in the *Abhandlungen*, of the Royal Bavarian Academy, of a large collection of fossil teeth of mammals obtained from the druggists' stores of various parts of China, where they are sold as medicine. Many of these teeth—locally known as dragons' teeth—appear to be obtained from caverns, but others probably come from the loess, or alluvium, while yet others are derived from older formations. Judging from the quantities in which they are sold in the bazaars, these teeth must exist in enormous numbers in some parts of the Chinese Empire. The remains include those of deer, antelopes, three-toed horses (*Hipparion*), rhinoceroses, *Chalicotherium*, ancestral forms of camel (*Paracamelus*), giraffes, okapi-like ruminants, pigs, hyænas, and sabre-toothed tigers. One of the hyænas (*Hyæna gigantea*) is by far the largest of its tribe, the upper carnassial tooth measuring two inches in length against one-and-a-half inches in the existing spotted species of Africa. Especial interest attaches to the ancestral camel, since North America is supposed to have been the original home of the *Camelidæ*, and that continent was in close connection with north-eastern Asia in Tertiary times. Not less noteworthy is the occurrence of remains of antelopes of an African type, as well as of others allied to the Indian nilgai. This seems to refute the theory that the antelopes of Africa originated in that continent (where the nilgai, which is a near relative of the kudu and bushbucks, is unknown), and to confirm Prof. Huxley's hypothesis that they are really immigrants from Asia.

At the first meeting of the Zoological Society for the present session, Mr. O. Thomas described a gigantic rat from New Guinea, which he regarded as representing a new genus, and named *Hyomys meeki*.

A fortnight later, at the second meeting of the same body, Mr. R. I. Pocock called attention to a remarkable habit of the Australian spiders of the genus *Desis*. These spiders live in the crevices of rocks between tide-marks on the shore, and by spinning a closely-woven sheet of silk over the entrance, imprison a mass of air in which they are able to live during flood-tide.

Two interesting additions have been recently made to the British vertebrate fauna. Till 1899, when it was detected on the coast of Brittany, the giant goby (*Gobius capito*) was believed to be a purely Mediterranean fish. During the past summer, Mr. F. Pickard-Cambridge, by carefully searching the rock-pools, has discovered this fish on the Cornish coast. One of his specimens is figured in *The Field*.

The second addition is an entirely new species of bank-vole (*Evotomys skomerensis*), from Skomer Island, off the Pembrokeshire coast. According to its describer, Captain Barrett-Hamilton, this species differs from the common bank-vole (*E. glareolus*) not only in colour and size (being much larger), but also in the structure of the skull; it belongs, in fact, to a distinct group of the genus. The description of this new species appears in the *Proceedings* of the Royal Irish Academy.

The Americans are about to undertake a great undertaking: nothing less than a complete biological survey of the Eastern Holarctic or Palæarctic region, that is to say, of the greater part of the extra-tropical area of the northern hemisphere. The proposed survey is to be undertaken on the lines of the one which is being brought to a conclusion in the United States, and it is calculated that it will take ten years to accomplish. The funds are to be supplied by the Carnegie Institute. Such a survey, it is urged, would alone enable us to understand the true relationship of the fauna of Northern Asia and Europe to that of North America, and would likewise help to explain the origin of both faunas. According to American ideas, the vast amount of material contained in the museums of Europe is of little or no use for such a purpose; and it is in contemplation to collect the whole vertebrate fauna of this vast area section by section. If the project be carried through, we may expect to be inundated with descriptions of so-called new species, comparable to the seventy which have just been named from the islands of Malaysia, by Mr. G. S. Miller, in a paper published in the "Miscellaneous Collections" of the Smithsonian Institution.

Dr. W. G. Ridewood recently exhibited to the Linnean Society the frontal bones of a horse showing a pair of rudimentary horns, very similar in position to those of some of the ruminants. In the opinion of the exhibitor, this feature can hardly be regarded as an instance of reversion, since none of the extinct ancestors of the horse, of which (as indicated in an article in our present issue) the series is remarkably complete, show any traces of similar appendages. It is unfortunately not known whether the bony cores were covered in life with horn. This interesting specimen has been presented by Mr. A. Broad, of Shepherd's Bush, to the British (Natural History) Museum, where it is now exhibited.

Notices of Books.

"BRITISH MAMMALS: AN ATTEMPT TO DESCRIBE AND ILLUSTRATE THE MAMMALIAN FAUNA OF THE BRITISH ISLANDS FROM THE COMMENCEMENT OF THE PLEISTOCENE PERIOD DOWN TO THE PRESENT DAY." By Sir Harry Johnston. (Hutchinson. Illustrated. Price 12s. 6d.—The author of this handsome addition to the "Woburn Library" is apparently convinced that it is illogical to separate the animals of to-day from those of yesterday, and he accordingly includes in his account of the mammals of the British Islands not only those now to be met with there in a wild state, but likewise those that have been exterminated within the historic period, together with those extinct forerunners of the latest geological epoch. Whether this method is any more logical than the one which excludes extinct types may well be a matter of opinion, for if the animals of yesterday come within the scope of the work, there is no reason why those of the day before should be left out in the cold. Accepting, however, both his extension and his limitation of the subject, we think that Sir Harry Johnston has succeeded in producing a very readable and attractive book, and one which may, in its general scope and style, well form a model which more scientific zoologists would do well to copy. An absence of details is noticeable, and the relations of the few surviving British mammals to their relatives in other lands and to their extinct predecessors are sketched in a manner which cannot fail to interest. Indeed, the work is much more than is indicated by its title, since it treats largely of mammals in general.

While commending the general style of the work, we must at the same time warn our readers that it must by no means be accepted as an exhaustive account of British mammals, or one that is free from errors. For instance, while in the case of one species of the mouse tribe the local sub-species are given, in some of the others they are omitted. This, of course, is inexcusable. It would have been perfectly legitimate to ignore sub-species *in toto*, but to notice them in one case and omit them in others, can only be taken to mean either that the author is inexcusably careless, or that he knows his subject imperfectly. We might also refer to certain inconsistencies in regard to nomenclature, did space permit. To justify the assertion that the book is by no means free from serious errors, we may cite the statement on p. 269 to the effect that ancestral rhinoceroses had four toes on each foot, and also the one on p. 370 that

Macaque monkeys are the only representatives of their kind which in Asia inhabit districts with a climate as cold as that of England. The author's theories, too, must be accepted with reserve—notably the suggestion (p. 366) that American monkeys originated in Africa, seeing that not a vestige of the remains of one of these creatures has hitherto been discovered in that continent.

A striking feature of the volume is formed by the coloured plates reproduced from the author's own sketches, which differ markedly in style from the illustrations commonly seen in zoological works. As to the merits of these sketches, we must, however, leave our artist friends to decide.

"THE MOON: CONSIDERED AS A PLANET, A WORLD, AND A SATELLITE." By James Nasmyth, C.E., and James Carpenter, F.R.A.S. (Murray.)—The moon is a dead and unchanging world. As it was when Galileo looked upon it through the first telescope, so it was when Nasmyth and Carpenter brought out the third edition of the "Moon" in 1875, and so it is to-day, when the publishers have issued a verbatim reprint of the same book. Perhaps it is because of its unchangeableness that so little progress in our knowledge of the moon seems to have been attained in the last quarter of a century or more, for the joint authors raise the same problems, and give the same doubtful answers to the same questions that we do to-day. The book is in fact up-to-date for all intents and purposes. In illustration alone do we seem to have made a notable selenographical advance. When Nasmyth and Carpenter wrote, photography was a very unskilful assistant to the study of the moon, and their lunar drawings were (as they still are to-day) incomparably the finest representations made by hand of the moon's surface. The re-publication of the book in a more convenient size, and at the greatly reduced price of 5s., will meet with wide acceptance. The paper and print are both pleasing. We notice one misprint on p. 79, where [illegible] is written for [illegible].

"MINUTE MARVELS OF NATURE." By John J. Ward. (London: Isbister & Co.)—The aim of the author of this book is to exhibit in a popular manner some of the striking and interesting subjects which are revealed by the microscope, and to describe them in such a way as will attract the unscientific reader. To this end the book is freely and admirably illustrated by 184 reproductions, principally photo-micrographs, and they cover a very large range of subjects. Bearing in mind the purpose of the book, the critical judgment is largely suspended. Errors there are, but not such as substantially weaken its object. A microscopist is apt to become a little impatient when he sees a group of specimens which includes Anchors and plates from the skin of the Synapta included in the title of "Diatoms." Several other little blemishes occur, and the description of the manner of the use of the pulvilli of the fly's foot—for so long a subject of controversy—might with advantage be revised. Still the book, placed in the hands of one who is unacquainted with microscopical subjects, is likely to create interest and lead to a desire for further information and investigation: if it succeed in this, its purpose will be achieved.

"BUDDHIST INDIA." By Prof. T. W. Rhys Davids. Pp. xv + 332. (Fisher Unwin. Illustrated. 5s.)—The rise of Buddhism in India has provided Prof. Rhys Davids with a theme for a scholarly work. If India were subject to a nation like Germany, exploration of the rich field of historical research, of which this book gives us an inspiring sketch, would be made a subject of national concern; but here it is not considered necessary to make inquiries into the ethnology or archæology of the races which constitute our Empire, and it is left to scholars like Prof. Davids to rescue such knowledge from oblivion. It is usual to adopt the Brahmin idea of ancient India, with its doubtful theories of castes and history, but inscriptions and other records have provided material for the construction of a connected account of India without accepting the Brahmin point of view as the final one, and equally true five centuries before Christ and five centuries after. Prof. Davids describes from the available evidence the kings, clans and nations, social and economic conditions in India in the sixth and seventh centuries B.C. The Buddhist influence was most early felt in the north of India, and the picture of village life at that time shows that the "mass of the people, the villagers, occupied a social grade quite different from, and far above, our village folk." The claim of the priests to social superiority [illegible] recognised and the caste system as it is now understood [illegible] unknown. There were different families or clans, but the [illegible], in the exact use of the term, did not come into existence until long afterward. As to literature, the oldest reference [illegible] is in a tract dating approximately to 450 B.C. The priests appear to have been indifferent and even opposed to the use of writing. "All the present available evidence," remarks Prof. Davids, "tends to show that the Indian alphabet is not Aryan at all; that it was introduced into India by Dravidian merchants, and that it was not, in spite of their invaluable services in other respects to Indian literature, to the priests, whose self-interests were opposed to such discoveries, but to traders, and to less prejudiced literary circles, that India owes the invention of those improvements in the mechanical aids to writing that enabled the long previously existent knowledge of letters to be applied at last to the production and preservation of books." Limitations of space prevent us from mentioning more of the interesting points with which this volume is filled. Buddhism slowly but continually lost its place as a national faith, and now there is scarcely a Buddhist left in the land where Buddhism arose. Changes in the faith itself, changes in the intellectual standard of the people, and the influence of foreign tribes which invaded India from the north-west, are suggested as causes for the decline and fall of Buddhism in India. Prof. David's story of the rise of the faith, and the conditions of the people who professed it in India, is a contribution worthy of his great learning, and of great interest to every student of history.

"OBSERVATIONS OF A NATURALIST IN THE PACIFIC BETWEEN 1896 AND 1899." By H. B. Guppy, M.B., F.R.S.E. Volume I. "Vanua Levu, Fiji." Pp. xx., 392. (Macmillan.) 15s. This book is the work of one who does not shrink from detail; and it has more in common with the elaborate memoir of a State survey than with the ordinary record of a traveller. In a country where the annual rainfall varies from 100 to 250 inches, where the interior tends to become wilder and less populous, and where dense forest prevents the mapping of geological boundaries, Mr. Guppy has made elaborate notes of every rock-exposure that he could visit. He includes the fine volcanic necks that rise sheer above the agglomerate layers and the marine sediments of the plateaux; and he shows how the general volcanic action took place in Cainozoic times beneath the sea. Inclining, evidently, to a theory of upheaval, rather than to the difficult hypothesis of a recession of the level of the sea, he yet does not absolutely commit himself on this important subject. His unwillingness to generalise makes the book rather serious for the reader. The types of lava met with are classified with what seems an excess of detail, seeing that nothing new is revealed concerning their behaviour or occurrence as rock-masses. The felspar crystals are carefully measured under the microscope, and the presence or absence of fluidal structure in the ground mass is noted in each case. In dealing with the felspars which are commonly called "laths" by workers with the microscope, Mr. Guppy prefers the fourteenth century term "lathes." His phrase "lamellar extinction," moreover, does not strike us as a very happy one. Still less do we like the "formulæ" devised for the comparison of one rock with another. This is all very well for the note-book of one who is correlating a large series, but such a system seems hardly necessary in the published work. This cumulative evidence as to the interstratification of marine sediments and volcanic *débris* throughout Vanua Levu is of wide interest and importance; the minimum emergence (p. 315) that has made the present island is valued at 2500 feet. The history is one of a struggle between the forces of elevation and the constant planing action of the sea. A rise of another 600 feet would connect Vanua Levu with its sister island, Viti Levu, on the south-west. The plateau that forms a floor for the later accumulations is regarded as due to spreading lava flows (p. 336). Similar plateaux, completed in Oligocene times, and now buried in marine sediments, would doubtless be revealed by local elevation in the region between Ireland and the Faröe Isles. The whole book is admirably produced, but we cannot help thinking that it would have gained by considerable excisions, and by the substitution of a classified list of the localities from which specimens had been collected, in place of the detailed descriptions of so many individual instances.

"AMONG THE NIGHT PEOPLE." By Clara D. Pierson. Pp. xii. + 221. (John Murray.) 5s. It may be doubted whether any useful scientific purpose is served by regarding the lower animals as reasoning creatures possessed of sentiments like those of human beings and a vocabulary superior to that of many people. In the dainty book before us not only do raccoons, rats, foxes, weasels and other "varmin" carry on animated conversations, but also mosquitoes, caterpillars, fire-flies and moths. Children have no difficulty in imagining a doll or rocking horse to be endowed with life, so that the stories in this book will appeal to them vividly. Regarded as food for imagination, comparable with fairy tales and classical legends, the stories are very good and will please many young people. As for natural history, well, there is a vein of it among the whimsicalities described and the fine feelings pourtrayed, but the pity of it is that children will be unable to discriminate between what is real and what imaginary.

"MATHEMATICAL CRYSTALLOGRAPHY AND THE THEORY OF GROUPS OF MOVEMENTS." By Harold Hilton, M.A. Pp. xii. + 262. (Clarendon Press.) 14s. net. Earnest students of crystallography will be grateful to Mr. Hilton for his treatment of a branch of the subject usually neglected in English text-books. The geometrical theory of crystal structure is a fascinating field of study which the mathematician and the crystallographer can explore to the mutual advantage of both. From considerations of symmetry and finite groups it is shown that there are only thirty-two groups of movements consistent with the law of rational indices, and therefore applicable to crystallography. The argument thus develops the thirty-two crystal classes given in text-books on the subject. Three chapters are devoted to the description of the more important properties observed in crystals, and with chapters, among others, on the points already mentioned, form the first part of the book. The second part is devoted to theories suggested to account for these properties, the methods and notation used by Schoenflies in his "Krystallsysteme und Krystallstructur" being closely followed. The work of other investigators of the geometrical theory of crystal structure, which may now be regarded as fairly complete, is included, so that the volume is of importance both for reference and as a supplement to modern text-books.

BOOKS RECEIVED

Direction of Hair in Animals and Man. By Walter Kidd, M.D., F.Z.S. (A. & C. Black.) Illustrated. 5s. net.

The Cosmos and the Creeds. By Capt. W. Usborne Moore. (Watts.) 4s. net.

The Signs of Life. By Augustus D. Waller, M.D., F.R.S. (Murray.) Illustrated. 7s. 6d. net.

Essays and Addresses, 1900–1903. By the Rt. Hon. Lord Avebury, P.C. (Macmillan.) 7s. 6d. net.

Eton Nature Study and Observational Lessons. By Matthew Davenport Hill, M.A., F.Z.S., and Wilfred Mark Webb, F.L.S. (Duckworth & Co.) Illustrated. 3s. 6d. net.

School Geometry. Part V. By H. S. Hall, M.A., and F. H. Stevens, M.A. (Macmillan.) 1s. 6d.

Infection and Immunity. By Geo. M. Sternberg, M.D., LL.D. (Murray.) 6s. net.

St. Anselm. Proslogium. Monologium: An Appendix in behalf of the Fool by Gaunilon; and Cur Deus Homo. Translated by Sidney Norton Deane, B.A. (Kegan Paul.) 5s. cloth.

Evolution and Adaptation. By Thomas Hunt Morgan, PH.D. (Macmillan.) 12s. 6d. net.

New Theory of Organic Evolution. By James W. Barclay. (Blackwood.) 3s. 6d. net.

Some Indian Friends and Acquaintances. By Lt.-Col. D. D. Cunningham, C.I.E., F.R.S. (Murray.) 12s. net.

The Canon of Reason and Virtue. Translated by Dr. Paul Carus. (Kegan Paul.) 1s. 6d.

Guide to the Civil Service. By John Gibson, M.A. (Hodder & Stoughton.) 3s. 6d.

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THE ANCESTRY OF THE HORSE.

By R. LYDEKKER.

IF an expert mechanical engineer, totally unacquainted with zoology and comparative anatomy, were shown for the first time the skeleton of a tapir, and told that it belonged to an animal adapted to life in swamps, and were then asked if he could suggest improvements in the structure of the bony framework in order that the animal might be suited for a life on the open plains, and possess a high turn of speed, there would be little doubt as to the nature of his answer. After examining the short limbs, with two parallel bones in the second segment, and their three or four toes each, he would at once say that it is essential to lengthen all the bones of these portions of the skeleton, and to reduce the width of the foot either by diminishing the size of all the toes except the large middle one (which would have to be proportionately increased), or by doing away with them altogether. He might further suggest that it would be important to lengthen the bones of the lower segments of the limbs (except, of course, the three terminal ones) to a much greater extent than the upper one. And if he were specially inventive he might also point out that a much greater stride and far more mechanical power would be gained, if the animal could be made to stand only on the extreme tips of its toes, so that the whole of the hinder portion of the foot would be raised above the ground. Further, he might also advise that it would confer strength and solidarity on the limbs if the two bones in the second segment of each were welded together, so as to form but one.

If moreover, he were told that the tapir is probably a short-lived animal, which feeds on soft marsh vegetation, and that it was essential to obtain an animal whose span of life should be from fifteen to twenty years, and whose food should consist of dry grasses and grain, he would naturally look at the molar teeth of the tapir. These he would find to have low crowns surmounted merely by a few simple ridges; and if the skeleton belonged to an old individual, he would not be long in discovering that some or all of them were worn nearly or quite down to the roots. Obviously his answer would be that the crowns of the teeth must be very considerably lengthened; and, moreover, so constructed as to be more capable of resisting wear, and better adapted for grinding hard substances than are those of the tapir.

After this inspection of the skeleton of the tapir, we

must imagine our engineer to be introduced to that of the horse. "Here we have," he would say, "the very ideal animal you want, and I can suggest absolutely no mechanical improvement in its framework, save that I fail to realise the use of the two small splints of bone attached to the sides of the upper part of the cannon-bone in each limb."

Here, indeed, we have in a nutshell the essential difference between the horse (and its near relatives the zebras and asses) and its early ancestors, which, although of

FIG. 1.—Skeleton of *Hyracotherium*, of the Lower Eocene Period in North America and Europe. (After Cope.)

smaller size, were generalized creatures not far removed in their organization from the tapir. In the ancestral type there is abundant room for modification and specialization, whereas in the other the possibilities of improvement and advance appear to have been exhausted, and the animal is (with the aforesaid exception) practically perfect for its own special mode of life, and is the supreme development of which its line is capable. The mode in which this perfection has been attained during the slow course of evolution, it is my purpose, so far as space permits, to demonstrate in the present article.

The earliest mammal to which we can at present definitely affiliate the horse and its relatives is one from the lowest part of the lowest, or Eocene, division of the Tertiary period known as *Phenacodus*. This was a short-legged creature not larger than a fox, with a relatively small head, long tail, and five toes to each foot. On these five-toed feet the creature probably walked much in the same way as the modern tapir, that is to say that although the wrist and ankle joints were raised well above the ground, all the three bones of each toe were applied to the same, and the sole was provided with cushion-like pads. Very important is the circumstance that in each foot the middle toe was symmetrical in itself, and decidedly larger than those on either side. The toes—and more especially those in the fore-foot—were distinctly expanded at the extremity, and during life were encased in horny sheaths which were probably more like hoofs than claws. Not less important is it to notice that in the skull the socket of the eye was not closed behind by a bar of bone, and was thus continuous with the great hollow on the sides of the temples for the reception of the muscles which worked the jaw. As regards the teeth, it must suffice to say, firstly, that they were forty-four in number, as in so many of the early generalized mammals, and that although well-marked tusks, or canines, were present in both jaws, there was no distinct gap at the commencement of the grinding, or cheek-series. Secondly, these cheek-teeth had very short crowns, surmounted by four simple conical elevations, or cusps, between which were a couple of smaller cusps. Into other details of the structure of this primitive creature it would be out of place to enter here. As to its coloration in life, no one has, I believe, hitherto ventured to make even a suggestion.

When, however, we advance one step further in the scale, and come to the *Hyracotherium* of the London Clay division of the Eocene, American palaeontologists have been bold enough to say that the creature had a transversely striped coat comparable to that of the modern zebras; the reason for this being that all members of the horse tribe display, especially in the case of hybrids, a tendency to throw back, or revert, to a striped type of coloration. Whether we are justified in believing this ancestral striping to date so far back as the *Hyracotherium*, it is not for me to say.

As regards its organization, *Hyracotherium* differed markedly in many respects from the earlier *Phenacodus*, this being most clearly displayed in the skeleton of the feet (Fig. 2). The fore-foot had, for instance, become unsymmetrical, owing to the loss of the first, or "great," toe; the outermost of the four remaining digits being quite small, and having no fellow; the foot being thus comparable to the fore-foot of a tapir. The hind-foot, on the contrary, although more reduced, still retained the symmetrical form of the ancestral type, having lost both the first and the third digit, and thus being three-toed, like the corresponding foot of a tapir. *Hyracotherium*, which was no larger than a fox, still resembled its ancestor in having two bones to the second segment of each limb, that is to say a radius and ulna in the fore, and a tibia and fibula in the hind limb. Here it should be mentioned that between *Hyracotherium* and *Phenacodus* there may have existed an intermediate type with four toes to each foot. As regards its cheek-teeth, the creature presented a distinct

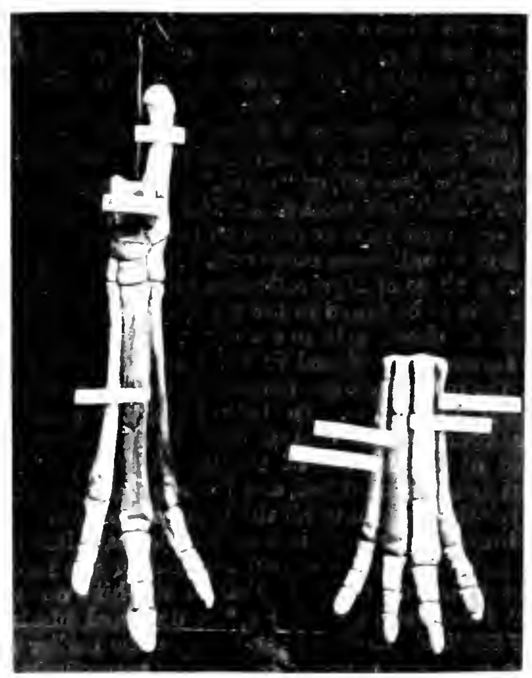


FIG. 2.—Bones of Left Hind and Fore Feet of *Hyracotherium*.

advance on *Phenacodus*. In the latter, as already said, the crowns of these teeth were surmounted by simple tubercles. On the other hand, in the former, three of these cusps in the upper teeth tend to unite to form an oblique anterior transverse ridge, while the three hinder ones tend to make a second posterior ridge; at the same time the two outer tubercles show indications of uniting so as to form a continuous outer wall to this part of the crown of

the tooth: this pattern being a forerunner of that obtaining in the cheek-teeth of the horse. The long tail of *Hyracotherium* was probably whip-like. Remains of the genus in question occur in the Lower Tertiary of North America as well as in that of Europe. In somewhat later deposits in both continents occur remains of more or less closely allied mammals known as *Pachynolophus*, which may or may not be in the direct horse ancestry. Later still, the well-known Palaeotheria of the Oligocene strata of France and England, some of the species of which

FIG. 3.—Crown Surfaces of a Right Upper Cheek-tooth of *Equus* and of Two Right Upper Cheek-teeth of *Anchitherium*.

were considerably larger than a tapir, were certainly off the main line of descent, their structure approximating more to that of the tapir type. When, however, we reach the Miocene Tertiary of both hemispheres we come upon remains of mammals which, although closely resembling the palaeotheria in dental structure, yet exhibit unmistakable signs of nearer affinity with the horse. In Europe these creatures are known as *Anchitherium*, but some of the American forms are separated generically as *Miohippus*, one of the points of distinction being that whereas the front, or incisor, teeth of the latter are of a perfectly simple structure, those of the former begin to exhibit a slight infolding of the summit of the crown, thus foreshadowing the deep pit, or "mark," characterising those of the horse. The cheek-teeth of *Anchitherium* (Fig. 3), though still low-crowned, have acquired fully-developed transverse crests, and a continuous outer wall. Numerically the teeth agree with those of *Hyracotherium* and *Phenacodus*, but a difference is to be found in the relatively small size of the first pair of cheek-teeth in each jaw. A marked advance on the former is displayed in the fore-foot, which by the loss of the outer digit has once more become symmetrical, with only three toes. In both limbs the cannon-bone and toe-bones of the central digit have become greatly enlarged at the expense of the lateral digits, which are proportionately diminished, and there is a marked increase in the relative lengths of all the bones of the lower portion of the limbs. Moreover, it is noticeable that although the radius and ulna in the second segment of the fore-limb, and the tibia and fibula in that of the hind one remain distinct from one another, yet the ulna and fibula have become relatively more slender than in the earlier forms, and are in places more or less welded respectively to the radius and the tibia. In the matter of bodily size an important advance has also been established, one of the European species of *Anchitherium* being approximately of the dimensions of a tapir. In one of the American species of the closely allied genus *Mesohippus* a remnant of the upper end of the metacarpal, or uppermost bone, of the outermost, or fifth, toe still persists.

The next advance in this wonderful evolutionary chain is presented by the members of the genus *Protohippus*, of the Upper Miocene formation. These animals were essentially horses, although retaining the three toes of the ancestral *Anchitherium*. The skull, for instance, had become relatively large and elongated, with the socket of the eye separated from the temporal pit behind by a bony bar, and thus enclosed by a complete ring of bone. The front, or incisor teeth, were separated by an interval from the tusks, or canines, which were relatively short, and divided by another gap from the teeth of the cheek-series. Moreover, the summits of the incisors were pushed in, like the in-turned fingers of a glove, thus giving rise to a distinct "mark" when half-worn. As regards the cheek-teeth, those of the first, or "milk" series, were curiously like the permanent set in the *Anchitherium*. The second, or persistent series, on the other hand, had acquired tall and squared crowns, which only developed roots when the animal was fully adult. In the pattern on the crown these teeth closely resembled those of the modern horse, with the exception of certain details which need not be noticed here; such pattern being the result of an excessive elevation of the simple crests of the *Anchitherium* molar, coupled with the pushing-in of certain portions, and the filling-up of the resulting hollows by the substance known as "cement," which is altogether lacking in the former. Then again, the first cheek-tooth in each jaw had become small and rudimentary. In the feet the lateral toes, although complete, had become relatively small, and scarcely, if at all, reached the ground, being in fact analogous to the rudimentary lateral toes of the ruminants. On the other hand, the central toe in each foot, with its supporting cannon-bone, was proportionately enlarged, and had become the real support of the body; the animal, like the modern horse, apparently standing solely on the

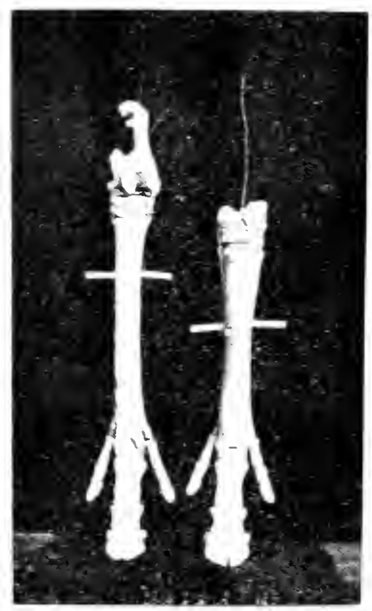


FIG. 4.—Skeleton of Left Hind and Fore Feet of *Protohippus*.

terminal joint of its middle toes. Higher up, the ulna in the fore-limb, and the fibula in the hind one, had become imperfect.

In the ordinary Pliocene three-toed horse, or *Hipparion*, of Europe and Asia, together with its North American representative, separated by some naturalists under the name of *Neohipparion*, the lateral toes were quite functionless, the ulna in the fore-limb had become fused with the radius, and the fibula in the hind-limb with the tibia, while the cheek-teeth had acquired somewhat taller and

more complicated crowns, and the gaps on each side of the canines were larger. Moreover, the small first cheek-tooth, or premolar, especially in the lower jaw, was quite rudimentary, and often shed in old age. There is, likewise, another point in connection with the cheek-teeth of this and the last genus. In *Anchitherium* and the earlier forms, the cheek-teeth, with their ridged crown-surface, were adapted solely for an up-and-down champing movement, such as occurs in the jaws of the pigs. On the other hand, the flat millstone-like surface formed by the cheek-teeth of the hipparion and the modern horse permits of a horizontal grinding movement, much better adapted to the comminution of hard substances. These three-toed horses were further peculiar for the presence of a depression on the sides of the face for a gland comparable to the tear-gland of deer and many antelopes; traces of the depression being visible in certain modern horse-skulls, and also existing in a much more marked degree in the extinct Siwalik horse (*Equus sivalensis*) of India.

The presence of these face-glands indicates that the hipparions probably frequented country covered with tall grass or bush, in which the scent given out by their secretion would aid the members of a troop in tracing the whereabouts of their fellows. On the other hand, in the open grassy plains (which by the way are probably a comparatively recent feature in the history of the earth) such aids are quite unnecessary, and the glands have accordingly been lost in the modern horse and its relatives. In height the hipparion stood about 4 feet 6 inches ($13\frac{1}{2}$ hands) at the shoulder. In coloration it was probably striped after the fashion of the zebras.

During the Pliocene period horses obtained for the first time an entry from the North into South America, where they developed into two generic types known as *Hippidium* and *Onohippidium*. Having large face-glands, and comparatively short and simple cheek-teeth, these South American horses were specially distinguished by the great length of the slit on each side of the face below the nose-bones. Evidently, therefore, they were off the line of the modern horse, although it is believed that the second, at any rate, were single-toed. If, as some believe, indigenous horses existed in South America at the time of its discovery, they must have been *Onohippidiums*.

In the Lower Pliocene of India and the Upper Pliocene of Europe and Asia appear for the first time true horses of the genus *Equus*, characterized by the total disappearance of external lateral digits, the sole relics of which are the splint-bones at the upper ends of the cannon-bones, alluded to above as being the only superfluous and apparently useless structures noticeable in the skeleton of the horse. They seem, in fact, to be structures of which these animals have been unable to rid themselves; and are actually injurious, being the cause of the disease known as splint. To the evolutionist they are, however, indescribably valuable, as affording incontrovertible evidence of the descent of the horse from the three-toed forms. In all the one-toed horses the pattern on the crowns of the upper cheek-teeth (Fig. 3) differs in a certain detail from that of the hipparions. The Pliocene horses approximate, however, in this respect more to the latter than in the case with their modern descendants, as they also do in the somewhat shorter crowns of the cheek-teeth. Moreover, the occurrence of a first upper premolar (the "wolf-tooth" of the vets.) was less uncommon in these Pliocene species than in the horses of to-day; and they occasionally developed the corresponding lower tooth, which is quite unknown in the latter. Whether, however, the mares of the Pliocene horses resembled those of the present day in the absence of the canines, I am unable to say.

Passing on from certainty to conjecture, it is probable that at least some of these Pliocene horses were striped like the zebras. Species, however, such as the immediate ancestors of the modern *Equus caballus*—the domesticated horse of the present day and its wild or semi-wild relatives—the dun-coloured ponies of Mongolia—the wild asses, and, in a less degree, the extinct South African quagga, which took to a life in the open plains in countries where there is strong sunlight, found this type of coloration unsuited to their needs and accordingly assumed a more or less uniformly coloured coat, as being best adapted for protective resemblance in such situations. The above-mentioned tendency to revert to stripes, especially in the case of hybrids, affords, however, proof of their zebra-like ancestry.

As early as the Prehistoric period, as we infer from the rude drawings of the animal by its first masters, the European horse was uniformly coloured—probably dun with dark mane, tail, and legs. It was a small heavy-headed brute, with rough scrubby mane and tail, and no trace in the skull of the depression for the face-gland. From this stock are descended the cart-horses and the ordinary breeds of Western Europe. The blood-horse, or thoroughbred, on the other hand, is a later importation into Europe either from Arabia, by way of Greece and Italy, or, as some think, from North Africa, the home of the barb. It has been supposed that these Eastern horses are the descendants of an earlier domestication of the same stock. I have, however, recently shown the existence in an Indian domesticated horse-skull, as well as in the skull of the race-horse "Ben d'Or," of a distinct trace of the depression for a face-gland, and the suggestion consequently presents itself that the Eastern horses (inclusive of thoroughbreds) are derived from *Equus sivalensis*, in which the face-gland may still have been functional. The thoroughbred, as contrasted with the cart-horse, exhibits the extreme limit of specialisation of which the equine stock is capable; this being displayed not only by the gracefulness and beauty of its bodily form and the relatively small size of its head and ears, but likewise by the greater relative length of the bones of the lower segments of the limbs as compared with the upper ones, namely, the humerus in the fore-limb, and the femur in the hind pair. In this respect, therefore, the blood-horse departs the furthest of all the tribe from its tapir-like ancestors, as it does in its height at the shoulder.

But it is not only in its skeleton that the horse exhibits traces of its affinity with its predecessors. On the hinder part of the foot a little above the hoof is a structure known to veterinarians as the "ergot." This, which apparently attains its greatest development in Grévy's zebra of Somaliland, corresponds with one of the foot-pads of the tapir, and points to a time when the ancestral horses applied the under surface of the fetlock to the ground. More remarkable still are the callosities, "chestnuts," or "castors," found on the inner sides of both limbs in the horse (inclusive of the Mongolian wild ponies), but only on the fore-legs of the other species, which are likewise rudimentary, or vestigial structures. Although it has been suggested that these also represent foot-pads (with which they by no means agree in position), it is far more probable that they are really remnants of glands (similar to those found in somewhat the same situation in the hind-limbs of many deer and the front ones of many antelopes), and that their disappearance as functional organs was approximately coincident with that of the loss of the face-glands of the hipparions, owing to both being no longer required. Even now, it is said, these callosities, when freshly cut, exude a humour the smell of which will cause a horse to follow for almost any distance.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

MICROSCOPICAL RESOLUTION.

For the meeting of the Royal Microscopical Society on the 19th November, a paper had been announced by Prof. Everett, F.R.S., dealing with "Microscopical Resolution." Those interested in the theory of the microscope who attended in the hope of increasing their knowledge of this aspect of the subject were doomed to be disappointed as far as this paper was concerned, for the learned author had evidently misapprehended the scope of Equation 32 of Lord Rayleigh's paper on "The Theory of Optical Images," recently reprinted in the R.M.S. Journal. The elementary formula which Prof. Everett deduced in the usual elementary way for the difference of phase between adjoining slits of a grating—and which Lord Rayleigh gives as No. 45—is quite correct, and leads, when discussed in a similarly elementary manner, to the familiar diffraction spectra, but without disclosing the not entirely unimportant intermediate secondary maxima. But Lord Rayleigh's paper goes far beyond this; it determines the *distribution of light in the final image* of a grating, with only these two simplifying assumptions: that the number of lines is infinite, and that the lines are negligibly narrow compared to the dark intervals.

The theorists were, however, fortunate in hearing an exposition from Dr. Johnstone Stoney, F.R.S.—a rare visitor—who was asked to speak.

Having pointed out that the familiar but elusive "rays" of light can be used only for elementary purposes, and must be supplanted by "waves" in all thorough investigations, and having alluded to his method of resolving undulations into plane wavelets, Dr. Stoney proceeded to communicate some extremely interesting results of his experiments with gratings.

He first showed how *two* lines a certain distance apart could be resolved by an aperture quite incapable of resolving a greater number of lines at similar distances. But whilst the lines are properly resolved—that is, separated by a dark interval—their distance apart is, in these circumstances, misrepresented. They appear too far apart in inverse proportion to the distance apart of the portions of two diffused diffraction fringes utilized. This is an experimental proof of the correctness of the reasoning leading to the Abbe theory, which is as novel as it is important.

His next point was equally interesting and valuable. When the number of lines in a grating is finite, and particularly when it is *small*, the complete diffraction spectrum produced by the grating is not limited to the familiar principal maxima; there are (n-2)—n being the number of lines in the grating—secondary maxima between every two principal ones, and those of these secondary maxima which are near a principal maximum are of appreciable brightness. Dr. Stoney has been able to demonstrate that these secondary maxima, when combined with the direct light, *the first diffraction-spectrum itself being excluded by reducing the aperture of the microscope*, are capable of giving a feeble kind of resolution. And, as in the previous case, there is again complete agreement between the results of the direct experiment and that to be expected theoretically, for the faint image secured in this way shows the exact defects and peculiarities which theory demands.

Dr. Stoney's third point also proved of interest. Perhaps the greatest defect of the published accounts of the Abbe theory lies in the utter want of definite information of a practical kind. It is stated that there can be no *complete* similarity between object and image unless every diffraction spectrum of appreciable intensity is utilised, and apparently with a view to impressing the confiding microscopist with the importance of this doctrine, certain experiments with the "Diffractions-platte" are mentioned which yield a dissimilarity between object and image that is absolutely startling. Of course, this is right when *complete* similarity is taken in its strictest sense, *i.e.*, down to the minutest detail, which, however, no practical man would expect to see under any conditions. What the latter desires to know is *how much* dissimilarity he must be prepared for, and to the practical man Dr. Stoney's testimony as to the remarkable improvement of microscopical images when the second spectrum is admitted must, therefore, be a welcome guide.

Dr. Stoney proceeded to make some further remarks on the importance of Condenser-adjustment in attempting very delicate resolving tests, but his interesting communication had to be terminated with a view to securing the remaining portion of the evening for another paper on the agenda.

Very few microscopists are really competent to appreciate the value of microscopical theory, and the high importance of taking every advantage that can be suggested for accurate manipulation. It is to be hoped, therefore, that Dr. Stoney's suggestions may, in due course, appear in print, and thus afford an opportunity to intelligent and thoughtful workers to assess them at their proper value. Dr. Stoney's remarks were not only of interest but to the point, for microscopical resolution was the subject which was opened by the somewhat disappointing paper which had brought our veteran physicist to this meeting.

QUEKETT MICROSCOPICAL CLUB.—The 408th ordinary meeting was held on November 20th, at 20, Hanover Square, W., the Vice-President, J. G. Waller, Esq., F.S.A., in the chair. There was as usual a large attendance of members and visitors. Mr. W. H. Langton exhibited a small portable microscope, which he had constructed without the use of a lathe. It was fitted with sliding coarse adjustment, two-speed fine adjustment, and motions to stage, substage and mirror. The various adjustable parts were kept in alignment with the body of the instrument by means of grooves in the ring fittings, the grooved rings travelling on a steel wire fixed in alignment with the body tube. Mr. Langton was complimented by many members on the ingenuity displayed in the construction of the instrument.

Mr. W. Wesché gave a demonstration, illustrated by the lantern, of the homology of the mouth parts of Dipterous flies with the mouth of the cockroach. It was shown how the mandibles were fused into the upper part of the proboscis of the blow-fly, and the maxillæ, or inner jaws, embedded in the base. Mr. Wesché also exhibited a number of minute palpi discovered by himself in many different species of Diptera.

Mr. L. R. Gleason gave an address on bacteriology as considered from the point of view of the amateur. It was illustrated by lantern slides of cultures and apparatus, and by specimens under the microscope. He wished to correct the popular idea that very high powers and expensive apparatus were a *sine quâ non* for bacteriological work. A great deal could be done with a ⅙th-inch objective and a little ingenuity in the preparation of apparatus. He would not, of course, recommend the amateur to undertake the culture of pathogenic germs, but the non-pathogenic germs were quite as interesting to study, and, moreover, were in many cases of the highest value to man. Linen, hemp, tobacco, opium, butter, cream, cheese, and a host of other domestic products were produced by the action of these invisible workers, and he trusted that many microscopists in search of a field for study would turn their efforts in this direction.

"JOURNAL OF THE QUEKETT MICROSCOPICAL CLUB."—The half-yearly number of this journal has just reached me, and contains several interesting and useful papers, amongst which I may mention Messrs. Marks and Wesché's "Further Observations on Male Rotifers," and a second part of Mr. D. J. Scourfield's "Synopsis of the well-known species of British Freshwater Entomostraca," dealing with the Copepoda. Mr. R. T. Lewis contributes a note on a hitherto undescribed species of *Chelifer*, illustrated by a plate; and Mr. D. Bryce has a note on two new species of *Philodina*. Among the more popular articles may be mentioned Mr. W. H. Harris' "Remarks on the Emission of Musical Notes, and on the Hovering Habit of *Eristalis tenax*"; and amongst practical notes one by Mr. H. J.

Quilter on "A Method of taking Internal Casts of Foraminifera," which should prove useful to students, and might be capable of extended application.

Watson's "Argus" Microscope.—A cheap microscope may generally be looked upon with suspicion, but Messrs. W. Watson & Sons have just brought out a new microscope, which is not only cheap but of excellent workmanship. The design has several novel features. The limb is rigidly attached to the stage, as in all Messrs. Watson's models, but the fine adjustment is of the direct acting micrometer screw type, actuated by an inverted head placed beneath the limb. The coarse adjustment is by means of a diagonally cut pinion which engages directly in the threads of the screw of this fine adjustment, there being another supporting wheel on the other side, so that one slide serves both for coarse and fine adjustment. The foot is of the tripod pattern with a spread of nearly 7 inches; the body is inclinable; the stage is 3½ inches square; and the body is provided with a draw-tube giving a variable tube-length of from 5½ to 9 inches. The eyepieces are the R.M.S. standard Continental size, *i.e.*, ·9173 inch. There are adjustable double mirrors, and a ring beneath the stage of the R.M.S. standard gauge, for condenser, &c. Compensating screws are provided for the working parts of the microscope. For this particular microscope Messrs. Watson have introduced a new series of objectives at specially low prices; but of these I shall have more to say when I have had an opportunity of examining them personally.

New Method of Mounting Rotifers.—I have recently seen some Rotifers mounted by a method which appears to me to have several novel points. The Rotifers, which were of the genus *Megalotrocha*, are now more than two years old, but are as bright and clear as when first mounted. They were put up by Mr. W. Brockett, Laboratory Assistant in the Zoological Laboratories at Cambridge, and I am indebted to him for the following explanation of his method. A few living Rotifers are put in a large drop of water on an ordinary slide. They are then narcotised by the addition to the water of a very few granules of cocaine. When perfectly extended, after examination under a lens or a microscope, a drop of two per cent. osmic acid is placed on a clean cover-glass, which is then rapidly inverted and as quickly lowered on to the Rotifers. Actual contact, and therefore compression of the animals, is prevented by small pieces of gum label being stuck on the slip at each corner of the cover-glass, so as to make four small supports. The osmic acid is allowed to remain from one to three minutes, the progress of the staining being carefully watched under the microscope, after which distilled water is run under the cover-glass by the "irrigation" method. This is merely the placing of a small quantity of the irrigating fluid at one side of the cover-glass and applying a piece of blotting paper to the opposite side, by which means a current is set up and the fluid drawn under the cover-glass. By the same method of irrigation, picro-carmine is then also drawn under, and allowed to stain for ten to thirty minutes, the progress of the staining being carefully watched as before. Finally, by the same method, there must be gradual dehydration with 30 per cent., 50 per cent., 70 per cent., and 90 per cent. alcohols in the order given, after which follows clearing with the usual clearing agents, and mounting (still by the same method of irrigation) with balsam dissolved in absolute alcohol. The slides will then appear of a milky opacity, and be apparently useless, but should be put aside for twenty-four hours, when they will become clear and limpid. This clearing-up can be hastened by the application of moderate heat, but the risks are manifold. It will be noticed that an essential part of this method is the non-disturbance of the Rotifers from the time they were narcotised, and the drawing between cover-glass and slip, of all the staining and dehydrating re-agents, and of the mounting medium, by the method of irrigation.

Microscopical Material.—By the kindness of Mr. C. S. Poulter, of Wallington, I am able to offer to the microscopical readers of Knowledge some leaves of *Deutzia scabra*, showing stellate hairs, and of *Elæagnus edulis*, showing peculiar scales. Those who desire to avail themselves of this material, should send me a stamped addressed envelope, together with the coupon appearing in the advertisement columns of this journal.

NOTES AND QUERIES.

C. Judson.—There is no reason why the numerical aperture of substage condensers as well as of objectives should not be determined by the method described in Knowledge of November last. It should be borne in mind, however, that the essential value of a condenser lies less in its total aperture than in the aplanatic cone which it is capable of transmitting, namely, in that portion of its cone of light which is properly corrected. Thus the Abbe form of chromatic condenser with a numerical aperture of 1·2 or 1·4 N.A. has an aplanatic aperture of not more than ·5, whilst the recent English achromatic condensers of 1 N.A. have aplanatic apertures varying from ·9 to ·95 N.A., and immersion condensers of 1·4 N.A. may have aplanatic apertures as high as 1·3 N.A. An objective is a complicated combination of lenses, so that the rules by which the focal length of a single lens may be determined do not apply to it, but what you probably require is not the focal length so much as the approximate equivalent focus, or, more definitely, the initial magnification. I hope to have a note dealing with these matters in the next issue of this Journal.

Power of Locomotion in Lophopus crystallinus.—Mr. Willoughby Dade, of 13, Northbrook Road, Dublin, writes: "There seems to be a division of opinion as to whether *Lophopus crystallinus* has power of locomotion or not. Indeed, most authorities say it has not. I have been keeping some colonies in a ten-inch bell-jar for some time, and am confident that they have this power. A short time since a group of about twenty individuals divided, and three or four days later the two colonies were fully a third of an inch apart, and now they are on different branches of a piece of milfoil. I find all the fresh-water Polyzoa in the Royal Canal here, excepting *Alcyonella*, which Allman says does not inhabit Ireland. *Lophopus* does very well in confinement, *Cristatella* only fairly well, but I am not successful with the tubed genera such as *Plumatella repens*, *Paludicella*, and *Fredericella*. These do not thrive, partly, I fancy, because *Cyclops* appears to be fond of picking the polypides out. I should be very glad to know with what success other pond-hunters keep these animals in captivity."

L. B.—It is exceedingly difficult to indicate the subjects, which would be likely to prove most interesting to you, in which the microscope could be used. There is so large a range, and every department dealt with intelligently provides such varied and interesting material for study and observation, that a knowledge of personal tastes and inclinations would be desirable before recommending. In the "Knowledge Diary" for 1904, obtainable from the publishers of this Journal, is an article entitled "Some Uses of the Microscope," which might prove of interest to you. It might be that on reflection you would prefer some other instrument, such as a telescope, in which case you would find the Diary referred to exceedingly valuable, for it contains: "The Heavens for 1904," "An Astronomical Summary," "Practical Work of a Small Telescope," and other scientific information.

T. Webster.—The publisher of Knowledge, to whom I have handed your letter, will be able to inform you of a likely place to obtain a table similar to that described by Mr. Morgan. The description and illustration were intended to aid those who were interested in getting such a device constructed locally, but so many readers have enquired for a source of supply that the publisher has taken the matter in hand.

J. J. Macdonald.—It would be impossible to give any explicit direction as to the size of stop required to produce a black background without knowing the condenser and objective that were to be employed, together with the numerical apertures of both. It is likely that you are attempting to obtain a black background with an objective possessing too large an N.A. Except the aperture of the objective be cut down, it is not convenient to obtain black ground illumination with numerical apertures in excess of ·75.

Communications and enquiries on Microscopical matters are cordially invited, and should be addressed to F. Shillington Scales, *"Jersey," St. Barnabas Road, Cambridge.*

BOTANICAL NOTES.—It is probable that the legend respecting the origin of the Glastonbury Thorn is well known. How Joseph of Arimathea, in visiting Britain on a preaching mission, arrived weary at Glastonbury, and while he rested, his hawthorn walking stick was thrust into the ground. How it at once began to grow, and ever after, so the legend says, flowered on Christmas Day. The thorn is simply *Crataegus Oxyacantha praecox*, an early flowering variety of our common hawthorn. That it does flower remarkably early is quite true, for a tree in the Royal Botanic Gardens, Kew, opens its flowers between November and March. This year it is now (early in December) bearing advanced flower-buds, which, had not the frosts injured them, would have expanded at Christmas time.

Another part of "Hooker's Icones Plantarum" has just been issued, and this contains descriptions and figures of several especially noteworthy plants. *Aniba megacarpa*, seen in the fruiting stage only, might easily be mistaken for an oak (*Quercus*), in which is found such remarkable variations in the cupules and acorns. This *Aniba* has a large, much-thickened cupule, and an oblong nut about three inches long. The genus belongs to the Laurineae. Rubber plants, to which an extensive literature is now devoted, are met with in this part of the "Icones" in two species of *Landolphia* and one of *Sapium*. *Landolphia Kirkii* is a very important plant, commercially. In an interesting note on the manner of collecting the rubber, we are informed that it "is collected in a way that is perhaps unique in any rubber-yielding plant. Some of the milk from a wound is allowed to coagulate. The pellet so obtained is applied to a fresh cut, and being turned with a rotary motion, the exuding milk is drawn off like silk from a cocoon. It is said that by working hard one person can collect five pounds of rubber *per diem*." In the other species of *Landolphia* figured, the rubber has to be coagulated by heat. Both are natives of Tropical Africa.—S. A. S.

THE FACE OF THE SKY FOR JANUARY.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the sun rises at 8.8 and sets at 3.59; on the 31st he rises at 7.44 and sets at 4.43.

Sunspots may now frequently be observed.

The earth is at its least distance from the sun on the 3rd; the sun has then its maximum apparent diameter of 32′ 35″·2.

THE MOON:—

		Phases.	H. M.
Jan.	3	○ Full Moon	5 47 A.M.
,,	9	☾ Last Quarter	9 10 P.M.
,,	17	● New Moon	3 47 P.M.
,,	25	First Quarter	8 41 P.M.

The moon is in perigee on the 4th, and in apogee on the 19th.

OCCULTATIONS.—The particulars of the occultations of the brighter stars during the month are as follow:—

Date.	Star Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. Point.	Angle from Vertex.	Moon's Age.
			h. m.			h. m.	°	°	d. h.
Jan. [illegible]	111 Tauri	5·2	6 8 P.M.	12[illegible]	17[illegible]	6 40 P.M.	214	253	13 21
,, [illegible]	26 Geminorum	5·1	1 4 A.M.	[illegible]	[illegible]	2 2 A.M.	308	274	15 4
[illegible]	[illegible] Leonis	[illegible]	10 13 P.M.	129	167	[illegible] P.M.	259	295	18 1
[illegible]	D.M. +12° 436	5·9	7 19 P.M.	25	[illegible]	[illegible] P.M.	302	281	9 4
28	B.A.C. 1525	5·8	6 16 P.M.	70	[illegible]	7 2[illegible] P.M.	271	286	11 3
[illegible]	[illegible] Geminorum	5·6	3 [illegible] A.M.	100	[illegible]	4 [illegible]	275	234	12 11

THE PLANETS.—Mercury is an evening star in Capricornus. He is at greatest easterly elongation on the 1st, being 19°30 E., and sets for a few days near this time about $1\frac{1}{2}$ hours after the sun. On account of his great southerly declination, however, he is not favourably situated for easy observation. He is again in inferior conjunction with the sun on the 17th.

Venus is a morning star, and rises on the 1st at 4.22 A.M., and on the 31st at 5.28 A.M. Her brilliance, is, however, diminishing on account of increasing distance from the earth and greater southerly declination.

Mars is low down in the south-west at sun-set, but is very feeble and badly placed for observation.

Jupiter is on the meridian about sunset near the beginning of the month, whilst near the end of the month he sets about 9 P.M.

The diameter of the planet is diminishing on account of his increasing distance from the earth, the polar and equatorial diameters being 34″·3 and 36″·7.

The configurations of the satellites, as seen in an inverting telescope, and observing at 7 P.M., are as follow:—

Day.	West. East.	Day.	West. East.
1	3 2 ○ 1 4	17	3 ○ 1 2 4
2	3 1 ○ 2 4	18	2 ○ 3 4 ●
3	1 ○ 2 4 ●	19	2 1 ○ 3 4
4	2 ○ 1 4 3	20	○ 1 2 3 4
5	$\frac{1}{2}$ ○ 4 3	21	1 3 ○ 2 4
6	4 ○ $\frac{3}{1}$ 2	22	3 2 ○ 4 1
7	4 3 1 ○ 2	23	3 4 1 2 ○
8	4 3 2 ○ 1	24	4 3 ○ 1 2
9	4 3 1 ○ 2	25	4 2 1 ○ 3
10	4 ⊙ 2 ●	26	4 2 ⊙ 3
11	4 2 ○ 3 ●	27	4 ○ 1 2 3
12	4 2 1 ○ 3	28	4 1 ⊙ 2
13	4 ○ 1 3 2	29	4 3 2 ○ 1
14	$\frac{3}{1}$ ○ $\frac{2}{4}$	30	3 $\frac{1}{4}$ 2 ○
15	3 2 ○ 1 4	31	3 ○ $\frac{4}{1}$ 2
16	3 1 ○ 4 ●		

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Saturn and Uranus are lost in the sun's rays and cannot be observed.

Neptune comes to the meridian about 10.30 P.M., near the middle of the month; being close to μ Geminorum, he can readily be found by reference to that star, their respective positions on the 16th being:—

	Right Ascension.	N. Declination.
Neptune ...	6h. 17m. 16s. ...	22° 18′ 31″
μ Geminorum	6h. 17m. 11s. ...	22° 33′ 37″

The planet therefore will be 15′ directly south of the star, and will appear in the same field of view with a not too high power eyepiece. The above chart shows the planet's path during the year 1904.

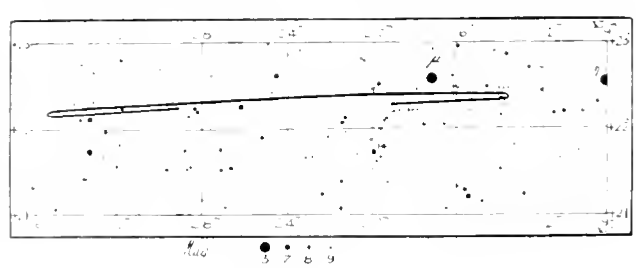


Chart showing path of Neptune in 1904.

METEOR SHOWERS.—

Date	Radiant R.A.	Radiant Dec.	Name	Characteristics
	°	°		
Jan. 2–3	230	+53	Quadrantids	Swift; long paths
„ 17	295	+53	κ Cygnids	Slow; bright

THE STARS.—The positions of the principal constellations near the middle of the month at 9 P.M. are as follow:—

ZENITH . . Perseus, Auriga (*Capella*).

SOUTH . . Pleiades, Taurus, Orion, with Aries and Cetus towards the S.W., and *Procyon* and *Sirius* towards the S.E.

WEST . . Pegasus, Andromeda, Aquarius and Pisces; Cygnus to the N.W.

EAST . . Leo (*Regulus*) low down, Cancer, Gemini (*Castor* and *Pollux*) high up.

NORTH . . Ursa Minor and Draco below *Polaris*, with Cassiopeia to the left and Ursa Major to the right.

Minima of Algol may be observed on the 10th at 1.21 A.M., 12th at 10.9 P.M., and on the 15th at 6.58 P.M.

TELESCOPIC OBJECTS.—Nebulæ.—Orion Nebula, situated in the sword of Orion, and surrounding the multiple star θ, is the finest of all nebulæ, and is so bright that it can be discerned with the naked eye; with a 3 or 4-inch telescope, it is best observed when low powers are employed.

Crab Nebula (M 1), in Taurus, situated about 1½° north-west of ζ Tauri in R.A. 5h. 29m., Dec. 21° 58′ N.

Clusters.—M 37, situated in Auriga, is one of the finest clusters, and very compact; its position is R.A. 5h. 46m., Dec. 32° 32′ N.

DOUBLE STARS.—β Orionis (Rigel), mags. 1 and 9, separation 9″. On account of the brightness of the principal star, this double is a fair test for a good object-glass of about 3-inch aperture.

δ Orionis, mags. 2 and 7, separation 53″; easy double.

ζ Orionis, triple, mags. 3, 6, and 10, separation 2″·5 and 56″; rather difficult in a 3-inch telescope.

λ Orionis, mags. 4 and 6, separation 4″·5; pretty double.

σ Orionis, triple, mags. 4, 8 and 7, separation 12″·5 and 42″. There are several other small stars near, and the detection of the fainter ones is looked upon as a good test of the light-gathering power of the telescope. With a 3-inch, one can see up to number 7, though 4 is very difficult.

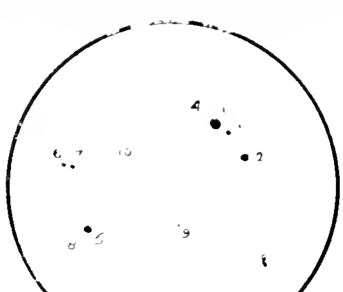


Diagram of σ Orionis.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, KNOWLEDGE Office, 326, High Holborn, and be posted by the 10th of each month.

Solutions of December Problems.

No. 1 (W. Geary).

Key-move.—1. B to B7.

If 1. . . .	K to B5,	2. Q to KBsq, ch.
1. . . .	Kt (Bsq) moves,	2. B × Kt.
1. . . .	P to R6,	2. Q to Q3ch.
1. . . .	P to Q5,	2. Q to Ksq, ch.
1. . . .	P to Kt5,	2. Q to Q4ch.
1. . . .	Kt (Q3) moves,	2. Q to Q3 mate.

No. 2 (C. D. Locock).

Key-move.—1. Kt to R8.

If 1. . . .	K to B4,	2. Q to R7.
1. . . .	K to K6, or Kt6,	2. Q × Pch.

SOLUTIONS received from "Alpha," 4, 4; W. Nash, 4, 4; G. A. Forde (Major), 4, 4; "Looker-on," 4, 3; G. W. Middleton, 4, 4; "Quidam," 4, 4; J. W. Dixon, 4, 4; C. Johnston, 4, 4; H. S. Brandreth, 4, 0; H. F. Culmer, 4, 4; T. Dale, 4, 4; J. Jones (Salford), 4, 4.

"*Looker-on.*"—After 1. Kt to B8 (which you give as an alternative to 1. Kt to R8), the defence K to B4 appears to be good; for if then 2. Q to R7, K × P. Many condolences on the loss of a point at the last and critical moment.

H. S. Brandreth.—After 1. B to Q5, K to B4; 2. Q to Bsq., K to Kt3. There is no mate.

C. Johnston.—Many congratulations. Please send your full address.

RESULT OF SOLUTION TOURNEY, 1903.

Winner of the KNOWLEDGE Challenge Trophy. C. Johnston, 83.

Winner of Second Prize (15s.).—"Looker-on" (G. J. Slater, Bolton), 82.

Winner of Third Prize (KNOWLEDGE for 12 months).—J. W. Dixon, 81.

These are closely followed by W. Nash and "Quidam," 80. Other scores worthy of mention being: G. W. Middleton, 73; "Alpha," 68; H. F. Culmer, 64; G. A. Forde (Major), 62; and T. Dale, 58. Mr. Dale did not compete during the first three months, or he would evidently have taken a much higher place.

The above award will remain open for one month.

The scores of the first five show the closeness of the competition, the result of which was in doubt till the last. Last year Mr. "W. Jay" came out with a clear lead of four points. In the present competition the holder of the trophy retired early, and Mr. C. Johnston, who tied for fourth place last year—20 points behind Mr. Jay—scores a well-deserved success and becomes the second holder of the Challenge Trophy. "Looker-on" (Mr. G. J. Slater, the well-known composer) once more taking the second place. Mr. Dixon, winner of the third prize, did not compete last year. The same applies to "Quidam"; Mr. W. Nash is a place lower.

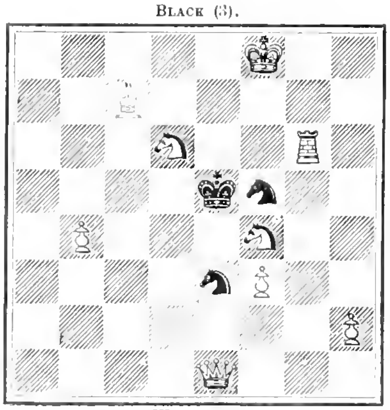
While sympathizing with "Looker-on" on his bad luck, the Chess Editor, who fully realized the difficulty of deciding what looked like a probable tie between two expert solvers, may perhaps be pardoned for congratulating himself on having effected a separation just in time to prevent the tie, by means of a problem specially composed for the occasion. He hopes that all last year's competitors, and many others, will take part in the new Solution Tourney which begins with the problems in the present number.

PROBLEMS.

No. 1.

By A. H. Human.

BLACK (3).



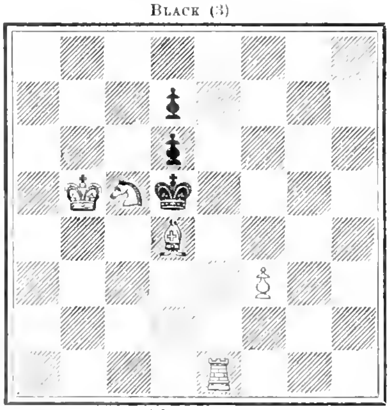
WHITE (9).

White mates in two moves.

No. 2.

By J. C. Candy.

BLACK (3)



WHITE (5)

White mates in three moves.

SOLUTION TOURNEY, 1904.

This year's Solution Tourney commences in the present number of KNOWLEDGE, and will continue till the end of the year. The winner will hold for twelve months the KNOWLEDGE Challenge Trophy. This will become the property of any solver who wins it three years in succession, or four years altogether. In the event of a tie between the previous holder and another, the holder will retain possession of the trophy; in that case, however, neither a win nor a loss will be scored to the holder. Should others than the holder tie for first place, the tie must be decided as below.

The second prize will be 15s., and the third prize KNOWLEDGE for twelve months. In the event of ties for either or both of these, the ties shall be decided by a further trial of skill under new conditions, or the prizes divided at the discretion of the Chess Editor.

The problems published will be either three-move or two-move direct mates, and not more than two will appear in any number. In the event of any problem being incorrectly printed, it will be cancelled and reprinted. Points will be awarded as follows:—

Two-move Problems.—Any one correct key, **2** points; a *second* solution, **1** point.

Three-move Problems.—Any one correct key, **4** points; a *second* solution, **2** points.

One point will be deducted for any *one* incorrect claim for a second solution. A correct claim of "no solution" will count as a correct key.

SPECIAL NOTE.—Duals will not score. All solutions must bear postmark of the issuing office not later than the 10th of the month of publication.

CHESS INTELLIGENCE.

The proposed match between Messrs. Blackburne and Marshall has been abandoned. Mr. Marshall is an enterprising player who aims high; but matches between leading chess-players have always been notoriously difficult to arrange. Mr. Marshall has lately been annotating many of the games in the *British Chess Magazine*, in the place of Mr. James Mason, who has been incapacitated by ill-health. At the time of writing we learn with regret that Mr. Mason has had a serious relapse. All chess players will wish him a speedy recovery.

Surrey defeated Sussex on November 21st, after a very closely contested match, by $8\frac{1}{2}$ games to $7\frac{1}{2}$. The games on the four top boards were all drawn. Surrey lost on the next three boards, but their "tail" proved strong enough to outweigh this, and give them the victory.

All manuscripts should be addressed to the Editors of KNOWLEDGE, 326, High Holborn, London; they should be easily legible or typewritten. All diagrams or drawings intended for reproduction, should be made in a good black medium on white card. While happy to consider unsolicited contributions, which should be accompanied by a stamped and addressed envelope, the Editors cannot be responsible for the loss of any MS. submitted, or for delay in its return, although every care will be taken of those sent.

Communications for the Editors and Books for Review should be addressed Editors, KNOWLEDGE, 326, High Holborn, London.

For Contents of the Last Two Numbers of "Knowledge," see Advertisement pages.

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Introduction.

As the announcement in the January number of "KNOWLEDGE" will have led our readers to expect, certain new features appear in this the first issue of the combined papers "KNOWLEDGE & ILLUSTRATED SCIENTIFIC NEWS." These features, which were characteristic of the younger of the two periodicals, take the form of articles on Physics and Applied Science; and if they prove acceptable to our readers, we propose to add to them as time goes on other articles and notes dealing with the progress of science in Chemistry and Electricity. At the same time it is proposed to discontinue none of the features which have been distinctive of "KNOWLEDGE," and which during many years have secured for it so large and influential a body of readers. All the contributors whose names were mentioned in the forecast which was published last December of the forthcoming volume of "KNOWLEDGE" have been retained, and their articles will appear during the ensuing twelve months. The Astronomical columns and their editorship will remain under the able direction which has controlled them hitherto: and the general articles and notes on Botany, Zoology, and Natural History will remain unchanged in general form and substance. The publication of the columns on Chess alone, it is proposed, owing to unavoidable circumstances, to postpone from this month until next, when a new announcement will be made. In concluding this brief notice of our intentions, we may express the hope that they are such as to meet with the approval of our readers.

Ancient Calendars and Constellations.

By E. WALTER MAUNDER, F.R.A.S.

It is generally asserted that the months of the year, both of the Accadian and Assyrian calendars, have an intimate connection with the constellations of the Zodiac; the great epic of Gilgamesh has been claimed as a zodiacal myth: and other myths and legends are explained in the same manner, or contain references which are apparently constellational. But we are thus sometimes involved in grave chronological difficulties, of which Assyriologists for the most part have taken no notice. It is therefore a very real service to science which the Hon. Miss Emmeline M. Plunket has rendered, in that she has recognised one of the most serious of these discrepancies, has called attention to it, and has striven to remove it.

The chief astrological work of Assyria is one in 70 tablets, drawn up for the library of King Sargon of Agané. The date at first assigned to this monarch was about 1700 B.C., for it was concluded that before this date the month Nisan, the first month of the Assyrian calendar, could not have corresponded with the position of the spring equinox in the first sign of the Zodiac, Aries. Later, however, a baked clay cylinder of Nabonidus, King of Babylon, who reigned from 555–538 B.C., was discovered, in which he described how he rebuilt the temple of the sun god at Sippar, and in the course of the work had found an inscription of Naram-Sin, the son of Sargon I., the original founder of the temple, "which for 3200 years had not been seen." From this tablet a little simple arithmetic led to the conclusion that the date of Sargon must have been about 3800 B.C.

These two determinations of the date of Sargon differ, it will be seen, by at least two thousand years; that is to say, by more than the entire length of the Christian era. The second determination of course follows inevitably, if we take the statement of Nabonidus at its face value. The first determination is equally inevitable if certain underlying assumptions are made. But both determinations cannot be right; a period of 2000 years cannot be treated as a negligeable quantity. Assyriologists in general stand by the date for Sargon of 3800 B.C. as "the best determined date in ancient history." Yet the obvious consequence has not been recognised, or at least not been practically admitted; namely, that the assumptions upon which the date of 1700 B.C. were based must, some or all of them, be incorrect. They still sometimes enter, explicitly or implicitly, into Assyriological papers without the slightest hint being afforded that so grave a doubt has been cast on their validity.

The assumption with which Miss Plunket deals is the one that the Accadian year originally began with the sun's entry into the zodiacal constellation Aries at the spring equinox. For spring equinox she would substitute winter solstice, and thus throw back the origin of the Accadian Calendar by 6400 years, to some date prior to the year 6000 B.C.

This suggestion is the text of Miss Plunket's book,* which consists of eight papers communicated at different times to the Society of Biblical Archæology, followed by notes explaining the numerous illustrative plates. She applies this principle to the explanation of the astronomy and mythology of Assyria, Media, Egypt, India, and China, displaying much research and not a little ingenuity in some of her explanations.

* "Ancient Calendars and Constellations." By the Hon. Emmeline M. Plunket. (John Murray.)

But it is not necessary to examine her arguments in detail. The objections to her fundamental principle are too serious. In the first place we may be very confident that the starting point of the original year was not fixed at a solstice. The difficulty to the first beginners in astronomical observation of determining the solstice must have been very great. For more than an entire month the sun does not alter its declination by a single degree; its places of rising and setting, its height at noon, show scarcely any change. But when we turn to the equinoxes we find a very different state of things. At that time three days make a greater difference in the sun's declination than thirty at the solstice. The height of the sun at noon changes from one day to the next by three-fourths of the sun's diameter. The most careless observers could not fail to recognise that either equinox was a point of time which could be determined with very great ease and precision. At these times of the year, too, and at these alone, the place of sunrise is precisely opposite the place of sunset. By half-a-dozen methods, all of the greatest simplicity, the time of the equinox could be fixed to a day.

Then it is not the case, as Miss Plunket avers, that Aries was the traditional constellation to lead the year. It is curious that some of the traditions which speak of a time when Taurus opened the year are expressly quoted by Miss Plunket. The familiar lines of Virgil in the first Georgic are an instance. Prof. Sayce, in the very same paper as that which Miss Plunket takes as her authority, quotes Ernest de Bunsen, "That Scorpio was taken as the starting point of the primitive Calendar," and Scorpio, of course, holds the same position with regard to the autumnal equinox that Taurus, not Aries, does to the vernal.

Miss Plunket, at the beginning of her fourth chapter, recognises that the great importance of Tauric symbolism in Median art seems to point to the fact that when the equinoctial year was first established, the spring equinoctial point was in the constellation Taurus, and she quotes Cumont to show that the great festivities in honour of Mithra were, as a rule, celebrated at the season of the spring equinox. Most opportunely a translation by Mr. Thomas J. McCormack has just appeared of Cumont's "Mysteries of Mithra," in which he gives a clear and most interesting account of the cult of Mithraism and of its distribution in Europe. The illustrations of the book render one fact of Mithraism very conspicuous; its intimate connection with the constellational figures, and especially with the signs of the Zodiac. In particular, the Bull, the Scorpion, the Lion, and the Man, the four constellations of the colures when Taurus held the vernal equinox, are the great Mithraic symbols. Yet most of these symbols extant were actually carved in the second century A.D., when their appropriateness to the four seasons had been completely lost.

But the vital objection to Miss Plunket's theory is that it assigns to the constellations an antiquity greater by some thousands of years than they can possibly possess. This is a point I have already taken up elsewhere, and I need only summarise the arguments here:

(1) The centre of the space not included in the ancient constellations must have been the south pole of the period when they were designed. This gives roughly the date 2800 B.C.

(2) This date accords with the tradition of the four Royal stars—Aldebaran, Regulus, Antares, Fomalhaut—marking the original colures.

(3) It gives the only symmetrical position for the actual constellations of the Zodiac.

(4) The ascending signs at this date faced east, the descending west.

(5) As shown above, there are traditions of Taurus leading the Zodiac; but there are none of Gemini, Cancer, or of any earlier sign.

Thus as to season and constellation and date, we must find Miss Plunket in error. But beside this error in principle there are several errors in detail, either as to astronomical fact or in computation.

Thus, for example, we find in the preface, p. viii., the times when the equinox entered Aries and Taurus, quoted from Prof. Sayce, as 2540 and 4698 B.C. respectively, but on p. 66 and elsewhere these dates are given as 2000 and 4000. These are not the only instances of a considerable looseness in dealing with the subject of precession. Thus, on page 37, Miss Plunket speaks of the stars of Aries attaining the southern meridian at midnight, two months after the summer solstice, between the years 1100 and 1400 B.C. Actually the constellation Pisces held that position. On pp. 166 and 167 the star Spica is said to have been in opposition to the sun on the 14th night of the first month at the time of the Exodus. This fixes the date of the Exodus as about 1300 years *after Christ*, *i.e.*, in the time of the Plantagenets!

There should be no very great difficulty in understanding the effect of precession. If we take the entire precessional period as 25,800 years, we find that the longitude of any star must increase one degree in $71\frac{2}{3}$ years. It is then a matter of the very simplest arithmetic to find out what star at any time was on the equinoctial colure, that is to say in zero longitude, and what were the longitudes of other stars.

So far from Aries having been the equinoctial sign as early as 2540 B.C., the first zodiacal star of the constellation about which we can be at all sure did not hold that position till 1650 B.C. The equinoctial point was still in the Pleiades—undoubtedly a portion of Taurus—as late as 2200 B.C., and Aldebaran, "the eye of the Bull," and the very central star of the constellation, was on the colure 3000 B.C. The earliest undoubted bright star of Taurus, Zeta Tauri, the tip of the southern horn, was in zero longitude 4080 B.C.

We can see at once why we have no tradition of the constellation of the Twins opening the year. The constellations were certainly mapped out much later than 4080 B.C. But the real difficulty, and it is a very important one, is to explain how it was that Aries came to be looked upon as the first sign at a comparatively early date. If we take the date 1650 B.C., for instance, the sun was then in conjunction with Delta Arietis (a star but little brighter than the 5th magnitude) at the spring equinox. But it was also in conjunction at the same date with Xi Tauri and Omicron Tauri, considerably brighter stars, and for practically one full month after the spring equinox the sun would be travelling through Taurus. It is not possible to conceive that at this period, when men had always from the very first beginning of astronomy been accustomed to regard Taurus as the first sign, they decided to give the primacy to Aries. It would be so easy for them still to consider Taurus as reaching to this point, which indeed it overlaps, and on any view, even if they considered the sun as in Aries on the actual first day of spring, four days later it would be unmistakably in Taurus. Practically the sun at the spring equinox was still at the first point of Taurus, and there was no need to make any change of the first sign.

* "The Mysteries of Mithra." By Franz Cumont. Translated by T. J. McCormack. (Chicago: The Open Court Publishing Co. London: Kegan Paul.)

Yet we may be sure that it would be only under something like compulsion that the change would be made, for we see how tenacious men are of old traditions by our own case, since we still speak of the first point of Aries, although the equinox has almost traversed the entire length of Pisces. It is almost universally forgotten that it was not until the equinox had been brought by the effect of precession right through a sign, to its very boundary, that that particular sign was in its true position to correspond with the first month of the year. The equinoctial point moves through the centuries by the effect of precession in the direction of diminishing longitudes; the sun in its annual course through the year moves in the direction of increasing longitudes.

It could not have been early, therefore, in the period which precession would ascribe to Aries that the primacy was transferred to that constellation. It is scarcely conceivable that it can have been before Hamal, the *lucida* of the constellation, had reached the colure, which it did about 700 B.C. There are no bright stars between Delta Arietis and Hamal; there is nothing whatsoever to have compelled an abandonment of a primeval custom. Indeed, it seems to me that there is only one theory by which we can account for the transference of the dignity of leader from the Bull to the Ram. If in the course of time the science of astronomy fell into abeyance, possibly through wars and revolutions and the conflicts of races, and all that remained was just the recognition of the old constellation forms which might well have been preserved by the peasantry, and then at a later date the science was built up anew, the position of Aries as the leader constellation would be perfectly natural. But if so, whilst we must take 2800 B.C., or perhaps, to speak in rounder numbers, 3000 B.C., as the time of the rise of the first astronomy, with Taurus as leader, the time of its revival with Aries as leader can hardly have antedated 700 B.C.

If, then, we find a poem or myth, evidently based upon the Ram-Zodiac, we may be fully assured that the date of its first origin was certainly not earlier than 700 B.C., and probably considerably later. For a myth is not likely to have taken thorough hold upon men's imaginations immediately after the acceptance of a novel scientific system, to explain which that myth had been imagined. Such a process is necessarily one of slow development.

I will take but one illustration; the epic of Gilgamesh has been sometimes claimed as a solar legend on account of a supposed connection between the twelve successive tablets which contain it, and the twelve signs of the Zodiac. The hero is the sun, and the epic describes his progress through the twelve signs in the course of a year, the eleventh tablet which gives the account of the Deluge corresponding to the constellation Aquarius, the eleventh sign of the Ram-Zodiac. But Assyriologists would not be willing to admit that the Deluge Story was no older than the eighth century B.C. It follows, therefore, that the original Deluge poem must have been written when Aquarius was the tenth sign of the Zodiac, so that the legend cannot be interpreted as a poetic expression of the constellation figure. What applies to one sign applies to the rest, and the entire correlation imagined between epic and Zodiac breaks down at every point.

The question on which we have no light at present is as to the steps of the evolution, or the character of the catastrophe by which the Bull-Zodiac was superseded by the Ram-Zodiac. We can only be sure of one point, that, given the connection between the constellations and the months of the year which is usually assumed, then the Ram-Zodiac must be of comparatively modern times; later, probably a good deal later, than 700 B.C.

A Motor Aeroplane.

Successful Trials with a Man-Carrying Machine.

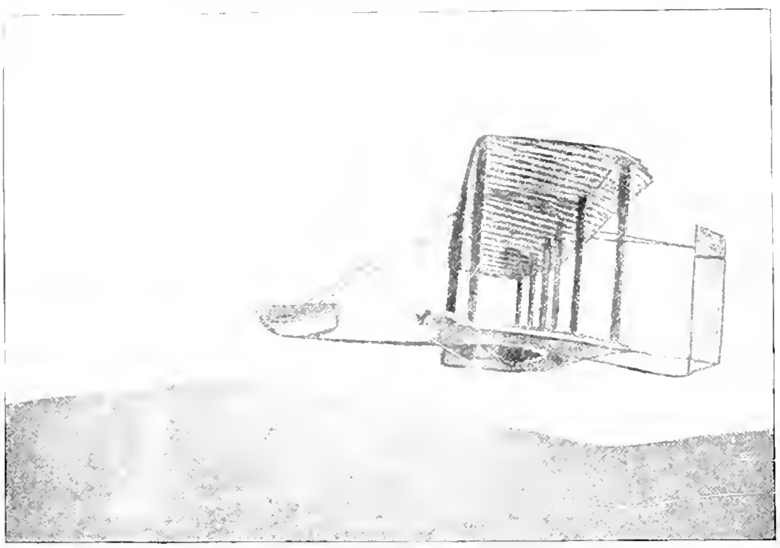
Many of our readers have doubtless been keenly interested in some of the experiments now being conducted in England, and especially in America, with flying machines. Hitherto but little success has attended the efforts of inventors, and though on a few occasions a model has shown its power of progressing through the air, yet all attempts to raise a man from the ground have proved abortive.

Various vague and sensational accounts have appeared in the Press during the last few weeks of a most important experiment made in America by the brothers Wright. We are now able to give an authentic account, kindly sent by Mr. Orville Wright himself, of what actually occurred. He states that he had not intended at present making any public statement with regard to the trials, but that "newspaper men" gave out "a fictitious story incorrect in almost every detail," so that the inventors feel impelled to make some corrections. The real facts were as follows:

On the morning of December 17, between the hours of 10.30 o'clock and noon, four flights were made, two by Orville Wright and two by Wilbur Wright. The starts were all made from a point on the levels and about 200 feet west of our camp, which is located a quarter of a mile north of the Kill Devil sand hill, in Dare County, North Carolina. The wind at the time of the flights had a velocity of 27 miles an hour at 10 o'clock, and 24 miles an hour at noon, as recorded by the anemometer at the Kitty Hawk weather bureau station. This anemometer is 30 feet from the ground. Our own measurements, made with a hand anemometer at a height of four feet from the ground, showed a velocity of about 22 miles when the first flight was made, and 20½ miles at the time of the last one. The flights were directly against the wind. Each time the machine started from the level ground by its own power alone with no assistance from gravity, or any other sources whatever. After a run of about 40 feet along a mono-rail track, which held the machine eight inches from the ground, it rose from the track and under the direction of the operator climbed upward on an inclined course till a height of eight or ten feet from the ground was reached, after which the course was kept as near horizontal as the wind gusts and the limited skill of the operator would permit. Into the teeth of a December gale the "Flyer" made its way forward with a speed of ten miles an hour over the ground and 30 to 35 miles an hour through the air. It had previously been decided that for reasons of personal safety these first trials should be made as close to the ground as possible. The height chosen was scarcely sufficient for manœuvring in so gusty a wind and with no previous acquaintance with the conduct of the machine and its controlling mechanisms. Consequently the first flight was short. The succeeding flights rapidly increased in length, and at the fourth trial a flight of 59 seconds was made, in which time the machine flew a little more than a half mile through the air, and a distance of 852 feet over the ground. The landing was due to a slight error of judgment on the part of the operator. After passing over a little hummock of sand, in attempting to bring the machine down to the desired height, the operator turned the rudder too far, and the machine turned downward more quickly than had been expected. The reverse

movement of the rudder was a fraction of a second too late to prevent the machine from touching the ground and thus ending the flight. The whole occurrence occupied little, if any more, than one second of time.

Only those who are acquainted with practical aeronautics can appreciate the difficulties of attempting the first trials of a flying machine in a 25-mile gale. As winter was already well set in, we should have postponed our trials to a more favourable season, but for the fact that we were determined, before returning home, to know whether the machine possessed sufficient power to fly, sufficient strength to withstand the shock of landings, and sufficient capacity of control to make flight safe in boisterous winds, as well as in calm air. When these points had been definitely established, we at once packed our



A Wright Machine—A side view.

goods and returned home, knowing that the age of the flying machine had come at last.

From the beginning we have employed entirely new principles of control: and as all the experiments have been conducted at our own expense, without assistance from any individual or institution, we do not feel ready at present to give out any pictures or detailed description of the machine.

It may be mentioned that the Messrs. Wright have for some years been conducting a series of experiments with "gliding machines," that is to say aeroplanes without any engine or propeller. With them the operator starts from the top of a hill and glides down through the air to the bottom, thus having to balance and control the machine.

We give here an illustration of one of the gliders, which is probably very similar to the machine recently tried, but the latter apparently had a motor and propeller added.

Electrical Novelties.

Messrs. F. Darton and Co.'s list of electrical novelties, just published, is remarkable for the cheapness of most of the articles which this firm supplies. The novelties include house telephones, hand gears and hand-geared dynamos for demonstration purposes, and their well known small dynamos for working with small oil engines. This firm also has a number of attractive small electric light sets and economical motors for fans and light electric power work.

Giant and Miniature Suns.

By J. E. GORE, F.R.A.S.

IT was at one time thought a probable hypothesis that the stars were in general of approximately equal size and brightness, and that their difference in brilliancy depended chiefly on their relative distance from the earth. On this apparently plausible hypothesis, we should have —taking the accepted "light ratio" of 2·512—an average star of the first magnitude equal in brightness to 100 stars of the sixth magnitude. As light varies inversely as the square of the distance, this would imply that a star of the sixth magnitude —that is one just steadily visible to average eyesight in a clear and moonless sky—would be ten times farther from the earth than a star of the first magnitude. For the same reason, a star of the eleventh magnitude would be at ten times the distance of a star of the sixth magnitude, and therefore 100 times the distance of one of the first magnitude. An eleventh magnitude star is about the faintest just steadily visible with a telescope of 3 inches aperture. For stars of the sixteenth magnitude, or about the faintest visible in a 25-inch refractor, the distance would be—on the above hypothesis—1000 times the distance of a first magnitude star.

Although this hypothesis was plausible enough at first sight, there never was any real evidence to show that the stars are of equal size and brightness, and modern researches have proved that they differ greatly in absolute size, and also in intrinsic brilliancy of surface. Measures of distance have shown conclusively that several small stars are considerably nearer to us than some bright stars, such as Arcturus, Vega, Capella, Rigel, and Canopus. These brilliant orbs must therefore be vastly larger than the faint stars which show a larger parallax. On the other hand, we have reason to believe that many stars are much smaller than our Sun. A consideration of some of these giant and miniature suns, as they may be termed, may prove of interest to the general reader.

We will first consider some of the "giant" suns. The well-known reddish star Aldebaran (α Tauri) in the Hyades may be taken as a standard star of the first magnitude. A small parallax of 0·107 of a second of arc was recently found for it at Yale College Observatory (U.S.A.). This makes its distance from the earth about seven times that of α Centauri (of which the parallax is 0"·75). Now, as Aldebaran has the same spectrum (K 5 M, Pickering) as the fainter component of α Centauri (magnitude 1·75), the two stars may be considered as fairly comparable in intrinsic brightness. From the above data I find that Aldebaran is about 92 times brighter than the companion of α Centauri and its mass about 882 times greater. But the components of α Centauri are of equal mass, and each equal in mass to our Sun. Hence Aldebaran has probably a mass 882 times greater than that of the Sun!

The red southern star Antares (α Scorpii) is of magnitude 1·22, according to the most recent measures at Harvard Observatory, and its parallax, according to Sir David Gill, is about 0"·021. Comparing with Aldebaran, we have the latter 1·159 times brighter. But Antares is at five times

the distance of Aldebaran. Hence the real brightness of Antares will be $\frac{5}{1\cdot159}$, or 21·5 times greater than that of Aldebaran. The surface of Antares would therefore be 21·5 multiplied by 92, or 1978 times the surface of the companion of α Centauri, and its mass about 88,000 times the mass of the Sun—a truly giant orb!

Betelgeuse (α Orionis) has a similar spectrum to Antares, but as it is brighter and its distance greater it is probably larger still.

Rigel (β Orionis). Assuming a parallax of 0″·01 found by Sir David Gill, and comparing it with the *brighter* component of α Centauri, which is of nearly the same apparent (or stellar) magnitude, we have, since the parallax of α Centauri is 0″·75,

Light of Rigel = 75^2 = 5625 times light of the Sun (which is probably the same as that of α_2 Centauri). But the spectrum of Rigel shows that it is hotter and brighter than our Sun. The two bodies are therefore not exactly comparable, and we must make an allowance for their difference in intrinsic brightness. If we assume that the Sun's light is reduced by absorption in its gaseous surroundings to one-fourth of its real light—which is probably a liberal allowance—we have,

$$\text{Surface of Rigel} = \frac{5625}{4} = 1400 \text{ times surface of Sun.}$$

From this it would follow that the volume of Rigel is about 52,000 times that of the Sun. Rigel is, however, probably of less density than our Sun, owing to its higher temperature. Comparing it with Algol, which has a similar spectrum, and of which the density and mass are known, we have the surprising result that the mass of Rigel is about 20,000 times the mass of the Sun! The parallax of Rigel is, of course, somewhat doubtful, but Sir David Gill is confident that it does not *exceed* the small quantity above stated.

For β Centauri, Gill found a parallax of 0″·046. Placed at the distance indicated, the Sun would shine as a star of about 6·75 magnitude, and as the photometric magnitude of the star is 0·86, we have a difference of 5·89 magnitude, which would make β Centauri 227 times brighter than the Sun. This gives a volume 3420 times the Sun's volume, and assuming the density at one fourth of the Sun's, we obtain a mass for β Centauri equal to 855 times the Sun's mass!

α Crucis is of almost exactly the same brightness as Aldebaran, but it is at double the distance from us, a parallax of only 0″·05 having been found by Gill. Its spectrum (of the "Orion type") indicates, however, that it is a much hotter and brighter body than Aldebaran. Taking its greater distance into account, we may perhaps conclude that it is comparable in size with Aldebaran, and therefore a sun of great size. The star β Crucis, whose stellar magnitude is 1·50, but which has no measurable parallax, must also be a giant sun. Its spectrum is the same as that of α Crucis.

Arcturus and Pollux have similar spectra (K. Pickering). The photometric magnitude of Arcturus is 0·24 and that of Pollux 1·21. The parallax of Arcturus, as found at Yale Observatory, is 0″·026, and that of Pollux 0″·056. From these data it would follow that Arcturus is $11\frac{1}{2}$ times brighter than Pollux. The Sun placed at the distance of Arcturus would shine as a star of about the eighth magnitude, or about 7·7 magnitudes fainter than Arcturus appears to us. This would imply that Arcturus is about 1200 times brighter than the Sun. It must therefore be a sun of gigantic size—probably one of the largest bodies in the universe. The above calculation would make Pollux about 100 times brighter than the Sun.

The bright stars Canopus and Procyon have very similar spectra, but the parallax of Canopus does not exceed 0″·01, while that of Procyon is about 0″·32. Still Canopus is a brighter star, its photometric magnitude being −0·86, while that of Procyon is + 0·48, a difference of 1·34 magnitudes in favour of Canopus. From these data I find that Canopus is 3500 times brighter than Procyon, and it follows that its volume is 207,000 times the volume of Procyon! If the densities are the same, the masses will be in this ratio, and as the mass of Procyon, as computed from the orbit of its satellite, is about five times the mass of the Sun, we have the mass of Canopus more than that of a million of suns! This is probably the largest sun of which we know anything. Sir David Gill's observations show that the parallax of Canopus does not *exceed* the hundredth of a second as above stated. A smaller parallax would, of course, further increase its size.

The observations of "spectroscopic binary stars" enable us to determine their mass although their distance from us may remain unknown. As their actual orbital velocity can be measured with the spectroscope in miles per second, their distance from the earth is a matter of no importance in the computation of their mass. One of the most remarkable of these interesting objects is the southern variable star known as V Puppis. It is a variable of the Algol type, and also a spectroscopic binary. The plane of the orbit must therefore necessarily pass through the earth, or nearly so, and the mass of the system can be easily computed. The spectroscopic observations show the enormous relative velocity of 380 miles a second! and indicate a mass equal to about 70 times the mass of the Sun. The variation of the star's light shows, according to Dr. A. W. Roberts, that the component stars revolve round each other in actual contact, or nearly so, and that their mean density cannot exceed 1-50th of the Sun's density, or about 0·028 that of water. With such a small density and so large a mass the components must evidently be greatly expanded masses of gas, probably several millions of miles in diameter. The period of revolution is about 34 hours 54 minutes, a wonderfully short period for a pair of suns!

Let us now consider some suns of probably miniature size. The star Lalande 21,185 (7·5 magnitude) in the constellation Ursa Major has a parallax of about 0″·47. At the distance indicated by this comparatively large parallax, the Sun would shine as a star of about 1·7 magnitude, or over 200 times brighter than Lalande's star. Another small star in the same constellation, Lalande 21,258 (8·5 magnitude), has a parallax of 0″·24. This distance would reduce the Sun to about 3·2 magnitude, but it would still be 5·3 magnitudes, or over 130 times brighter than the star.

The small star Argelander-Oeltzen 17,415 of the 9th magnitude has a parallax of 0″·25. The Sun, if placed in the same position, would be over 200 times brighter than the star.

Another small star with a comparatively large parallax is Lacaille 9352. Its magnitude is 7·1, and the parallax about 0″·29. The Sun, if placed at the distance indicated by this parallax, would shine as a star of about 2·7 magnitude. This gives a difference of 4·4 magnitudes, and implies that the Sun is over 50 times brighter than the star. This star has the very large proper motion of 7″ per annum. It is a remarkable fact that the faint stars above mentioned are actually nearer to the earth than Aldebaran, which is one of the brightest stars in the sky.

The famous double star 61 Cygni is also probably of small mass. Taking its parallax at 0″·39, the Sun, if

placed at the same distance, would be reduced to a star of about 2·1 magnitudes, and as the photometric magnitude of 61 Cygni is about 5·1, we have a difference of 3 magnitudes in favour of the Sun. This makes the Sun nearly 16 times brighter than 61 Cygni, and would indicate that it has about 60 times the mass of the star. The spectrum of 61 Cygni is of the second or solar type, but not exactly similar to that of the Sun.

Some of the faint satellites to bright stars (mentioned in my paper on "Stellar Satellites") must be either bodies of small mass or slight luminosity. Take the case of Burnham's 14th magnitude satellite to Aldebaran. Assuming that its parallax is the same as that of Aldebaran, or about one-tenth of a second, we have the Sun reduced to a star of the 5th magnitude at the same distance. This would make the Sun 9 magnitudes, or about 4000 times brighter than this faint star! It must therefore be either a comparatively small body, or else it must have proceeded a long way on the road to the total extinction of its light. If we suppose the density and surface brilliancy to be similar, the ratio of the masses would be about 25,000 to 1, and this small star would be less than 14,000 miles in diameter. It seems highly improbable that a body so much smaller than the planet Jupiter should continue for long in the sun-like stage. More probably it is a "cooled down sun." If its mass is not miniature, its light is certainly small.

The sun if placed at the distance of Regulus would shine with about the same brilliancy as the $8\frac{1}{2}$ magnitude satellite to that bright star. This satellite has close to it a faint companion satellite of the 13th magnitude. As both are moving through space with Regulus they are evidently physically connected with the bright star and lie at the same distance from the earth. This 13th magnitude star is therefore $4\frac{1}{2}$ magnitudes, or over 60 times fainter than the Sun. The accuracy of the small parallax found for Regulus (0″·022) may perhaps be doubted, but there can be no doubt, owing to the common proper motion of all three stars, that Regulus and the faint satellite are at practically the same distance from the earth. The great difference in their light—nearly 12 magnitudes—indicates that Regulus is about 46,000 times brighter than its faint attendant. There must therefore be an enormous difference either in their size or the luminosity of their surface.

The measures of the double star α Ursæ Majoris show that it is a binary star. There is a difference of at least 9 magnitudes between the components, showing that one is at least 4000 times brighter than the other. Considerable difference in size or great discrepancy in surface brightness is therefore absolutely certain.

The bright star γ Draconis ($2\frac{1}{2}$ magnitude) has a faint companion of the 13th magnitude which seems to be travelling with it through space. The difference of $10\frac{1}{2}$ magnitudes between the two implies that one is at least 10,000 times brighter than the other. Their disparity in mass or inequality in surface brightness must therefore be enormous.

Although calculation shows that the companions of Sirius and Procyon are each equal to the Sun in mass, still, as far as luminosity is concerned, they may be considered as miniature, or at least minor, suns. If the Sun were placed at the distance of Sirius it would shine as bright as the Pole Star, whereas the Sirian satellite is only of the 10th magnitude, or nearly 1300 times fainter than the Sun. In the case of Procyon, the Sun placed in the same position would be over 16,000 times brighter than the faint attendant. These small stars are probably "cooled down suns" which are verging towards the total extinction of their light.

Another somewhat similar case is that of the binary companion to the star 40 (o^2) Eridani. This small binary star is of the 9th magnitude, while the primary star is about $4\frac{1}{2}$. As both have a common proper motion through space they are evidently physically connected, and therefore lie at practically the same distance from the earth. Professor Asaph Hall found a parallax of 0″·22 for the brighter star. Assuming this parallax for the binary pair, I find from Burnham's orbit a combined mass equal to 0·71 of the Sun's mass. Placed at the same distance the Sun would shine as a star of 3·28 magnitude, that is 5·72 magnitudes, or 194 times, brighter than the binary, which therefore seems to be another sun, or rather a pair of suns, on the road to extinction.

The globular clusters, composed as they are of such faint stars, suggest the inevitable conclusion that either the components are miniature in size, or else that these wonderful objects lie at a vast distance from the earth. Even an approximate distance has not been found for any of them. If we assume a parallax of $\frac{1}{50}$th to $\frac{1}{100}$th of a second—163 to 326 years' journey for light—the component stars of most of them would be considerably fainter than our Sun would be if placed at the same distance. On this assumption they would be relatively small bodies. On the other hand, if we assume a parallax of $\frac{1}{500}$th to $\frac{1}{1000}$th of a second—from 1600 to 3200 years' light journey—the Sun would be reduced to about the $13\frac{1}{2}$ to 15th magnitude, and this would make the component stars equal to or brighter than the Sun. That each of the stars which compose these clusters is equal to our Sun in size and brightness seems improbable, and perhaps the most likely supposition is that they are comparatively small bodies, and are not so far from the earth as is sometimes supposed.

Ceylon Pearl Oyster Fisheries.

Professor Herdman's Report to the Colonial Government.

IN 1801 the Island of Ceylon became definitively a British possession, and with the removal of Dutch power there passed into English hands the control and the proceeds of the "pearl oyster" fisheries. Since the occupation of the Island its pearl banks have, it is computed, brought over one million pounds sterling into the treasury chest of the Government.

Although the aggregate amount derived from the Ceylon fisheries is suggestive of a prosperous maintenance of the native industry, in reality the situation has long afforded ground for disturbing conclusions. In the year 1891 there was an extraordinarily abundant oyster yield, the estimated revenue being placed at one million rupees, whereas ensuing periods have demonstrated but a dismal tale of fishery failures. There was, however, a good fishery last year (1903). Theories and speculations have been put forth from time to time regarding the phenomena of these strange oyster disappearances, but comparatively little which might tend to throw real light upon the question has resulted from the discussions.

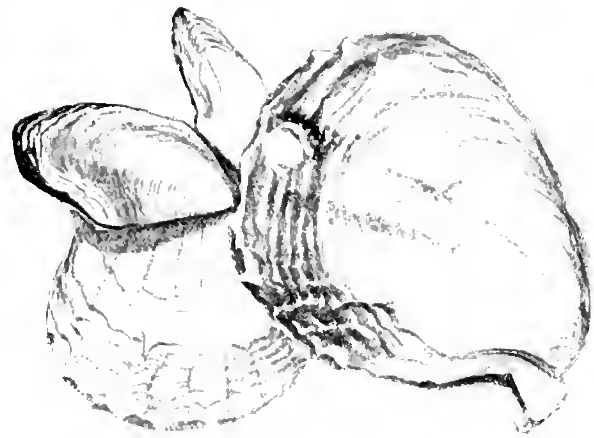
In such circumstances and mindful of the probable recurrence of conditions likely to profoundly modify or even jeopardise the pearl fishery, the Colonial Government determined in 1900 to seek outside and expert aid with the view of elucidating the scientific and economic

problems that were involved, and accordingly commissioned Professor W. A. Herdman, F.R.S., of the Natural History Department of the University of Liverpool, to proceed to Ceylon, in company with a qualified scientific assistant, to commence a survey and carry out a series of investigations and experiments. The steamship *Lady Havelock* was placed by the Ceylon authorities at Professor Herdman's disposal for the work of examining the biological surroundings of the pearl oyster banks, and during two successive cruises of three or four weeks each he inspected out at sea all the principal banks, established lines of dredging and trawling, and made observations across, around, and between the banks in order to ascertain the conditions that satisfy an oyster "paar," the term applied to the varied rocky strata (as opposed to shifting sandy layers) beneath the water which constitute the habitat of the animal. In all

Native Divers employed by Prof. Herdman.

these operations the Professor found an able coadjutor in Mr. James Hornell, his assistant, who, it may be added, is still in Ceylon furthering the enquiry. Enough, however, has already been accomplished to permit the issue of a detailed report embracing a description of the banks, and a record of the studies that were made on the life-history of the pearl oyster itself. The accompanying illustrations we are privileged to reproduce from this Report.

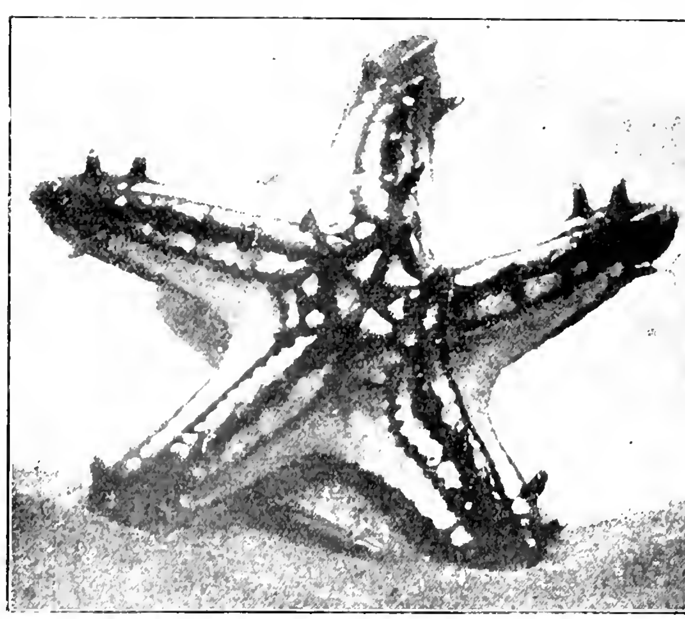
Much virtue often attaches to a name, but in the case of the so-called pearl oyster we have to disabuse our mind of any lingering belief that it is a true oyster, since, as a matter of fact, the animal belongs to the family Aviculidæ, and is therefore more nearly related to the Mussels (*Mytilus*) than to the Oysters (*Ostræa*) of British seas. One character in particular marks it off from *Ostræa*, namely, the ownership of a "byssus," or bundle of tough threads, by means of which it can tag itself on to rocks or other adjacent objects, as do its congeners, the Mussels. The species has favoured Ceylon waters, or, more strictly, the shores of the Gulf of Manaar on the north west, in countless generations from remote antiquity, hence, long prior to European rule; while the praises of the "orient" pearl have been uniformly ex-



A Bunch of Oysters from the sea bottom. Four generations are seen. The largest is 3½ years old, and the smallest, attached to the large shell, is about a month old.

tolled in many a classical allusion. All over the district the pearl oyster of the banks is the same animal, a decision that was quickly arrived at by Professor Herdman; furthermore, the method of fishery now pursued, even to the manning of the divers' boats and the custom of the cessation of diving at noon, is a continuation of ancient practice.

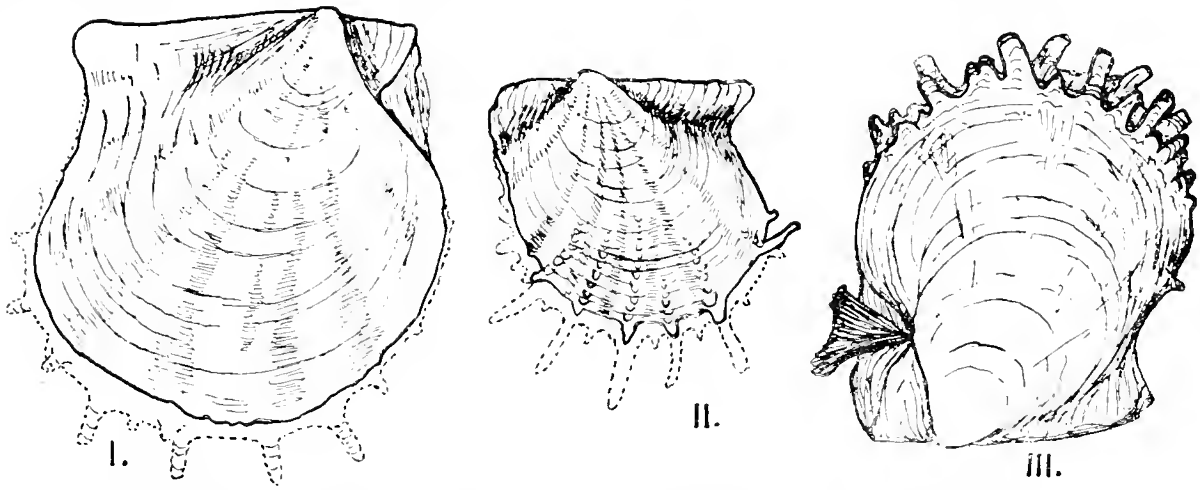
Of the causes which lead up to the disappearance of the oyster population—sometimes in hundreds of thousands—and the devastation of the banks, the Commissioner has much to say that is of interest. Influences such as oceanic currents, monsoon storms, and shifting sands have each their play; added to which, in common with other classes of marine denizens, the pearl oyster has its enemies. Boring sponges may destroy the shell, and boring molluscs suck out the animal. Then there are the star-fishes and carnivorous fishes to reckon with. But, as Professor Herdman remarks, compensation arises



One of the enemies of the Pearl Oyster. A starfish lying on a large oyster. Half natural size.

in these matters: for instance, one foe, a Plectognathid fish, which possibly devours very many oysters, at the same time receives and passes on the parasite which results in the production of pearls in others.

The life-cycle of the pearl oyster is described from the egg onwards to the adult animal, and the story unfolded is one of singular interest. *Margaritifera vulgaris* was, in fact, most seriously studied: partly in miniature experimental tanks, with the first aid of the microscope; again, in the hauls of the tow-net; and by means of diving trials at the sea depths, where, it may be noted, the oyster occurs on the rocky bottom in 5 to 10 fathoms of water. In the vicinity of the Manaar Gulf pearl banks this element is so clear that under the rays of a high sun the depths are brilliantly illuminated. A passing shadow will cause the animals to immediately snap-to their valves.



Three transplanted Oysters showing rapid growth. I. The dotted line indicates the new shell formed—23 days. II. New shell formed in 21 days. III. Oyster showing a month's growth—Natural size.

Valuation sample of Pearl Oysters in course of delivery from the inspection boats.

As regards pearl-formation, some pearls or pearly excrescences on the interior of the shell were detected as being due to the irritation caused by boring sponges and burrowing worms, but the minute grains of sand or other internal particles popularly supposed to form the nuclei of pearls are considered only to do so under exceptional circumstances. The majority of the best gems, on the contrary, are caused by the stimulation of a parasitic worm which becomes encased and dies. And this parasite is the Cestode larval *Tetrarhynchus*. Professor Herdman purposes dealing with this aspect of the question of pearl-formation at greater length later on.

Finally, there is one general conclusion that is reached in this opportune and admirable Report, and it is all-important. We are told that there is no reason for any feeling of despondency in regard to the future of the pearl fisheries of Ceylon if they are treated scientifically. Adult oysters are plentiful on some of the paars and seem for the most part healthy and vigorous; while young oysters in their first year and masses of minute spat just deposited are very abundant in many places. "The material exists, ready for man's operations."

[According to a *Times* telegram from Colombo on December 9th, 1903, Captain Legge, Master Attendant, on his return from inspecting the pearl banks, has decided against the proposed fishery this year. The next fishery will be in February, 1905.]

Astronomical Notes.

Sir W. Ramsay on New Gases and Radium.

SIR WILLIAM RAMSAY addressed the British Astronomical Association on December 30, on the subject of "Stars and Atoms." In the earlier part of his lecture he recounted the history of the discovery of the new gases, Argon, Helium, Neon, Xenon, and Krypton, exhibiting representations of their spectra, and explaining their places in the periodic series. He dwelt specially on the last-named gas with reference to its connection with Auroræ, and showed that the principal line in the auroral spectrum was the chief line of Krypton. Passing then to the discovery of radium, he described the properties of this element, including the three kinds of rays that it gives off, and suggested that we might find an analogy to the constitution of the molecule of this, the densest of all known elements, if we imagined a closely aggregated solar system, or better still, a stellar cluster, in which the collisions were frequent, or at least the perturbations often excessive, leading to the continual loss by the system of members whose velocities thus attained a greater than the critical. Such instability, he suggested, would be only perceptible in the case of unusually dense elements.

Solar Activity and Terrestrial Magnetism.

The principal subject of the papers at the Royal Astronomical Society, on January 8, 1904, related to the connection between solar activity and terrestrial magnetism. Mr. William Ellis pointed out an annual inequality in the frequency of auroræ as observed in these latitudes, corresponding to that established in the frequency of magnetic disturbances. Mr. Maunder drew attention to the two great periods of exceptional solar quiescence, and suggested a connection with the secular change of magnetic declination. Mr. Maunder examined the details of the nineteen greatest magnetic storms, since 1875, and the nineteen greatest sun spots, and suggested that the action from disturbed regions on the Sun might have a maximum effect in a given direction, and that this would explain quantitative discrepancies between certain sunspots and the magnetic storms which appeared to synchronise with them.

Stellar Magnitude of the Sun.

Mr. Charles Fabry, at the meeting of the Paris Academie des Sciences on December 28, 1903, communicated the result of his photometric determination of the stellar magnitude of the Sun. On December 7 he had reported that he found the Sun's light to be 100,000 times more intense than that produced by a decimal candle at a distance of one metre. A similar investigation, with the star Vega as the subject, gave the star's light as equal to that of a decimal candle at 780 metres. The stellar magnitude of Vega being taken as 0·2, that of the Sun was inferred to be −26·7.

Double Spiral Structure in Hercules.

Professor J. M. Schaeberle, in the *Astronomical Journal*, No. 552, announces his discovery of a double spiral structure in the great cluster in Hercules, the more pronounced spiral being clockwise, the other being counter-clockwise; the clockwise spiral being formed by the inner streams of *outgoing* matter, the seeming counter-clockwise spiral by that part of each stream which contains *returning* matter. The plane of the spiral is not normal to the line of sight. A precisely similar structure on a much larger scale appears to exist in the stars and nebulosity surrounding Gamma Cassiopeiæ.

Botanical Notes.

A New Rubber Plant.

Another plant containing rubber is now arousing considerable interest in Colorado, according to Mr. T. D. A. Cockerell's paper in the *Bulletin of the Colorado College Museum*, No. 1, where a description of the plant is given under the name of *Picradenia floribunda utilis*. It is a native plant, belonging to a North American genus of Compositæ, and resembles in appearance the French marigold genus (*Tagetes*), to which it is allied. Unlike most of the previously known rubber plants, this is a rather dwarf herb, and the rubber is obtained, not from a woody stem, but from the roots, where it is found in large quantities.

A New Genus.

A curious new genus is described in the Japanese *Botanical Magazine* for September, 1903, to which the name *Miyoshia* has been given. The only species at present known is a small, saprophytic, leafless plant, quite destitute of chlorophyll. It was found in a forest in the province of Mino, Japan. The author considers the genus to be closely related to *Aletris* in Liliaceæ, but as he cannot fit it into any already established order he has put it into a new one, which he has called Miyoshiaceæ. The tubeless perianth and semi-inferior ovary suggest some Hæmodoraceæ.

Root Formation.

In the *Österreichishe Botanische Zeitschrift* for December, 1903, Leopold Ritter von Portheim records his observations on root-formation on the cotyledons of *Phaseolus vulgaris*. Experiments with beans carried on for five years before 1901 were unsuccessful, but in that year the desired results were obtained in eleven cases. The plants were grown in the dark in distilled water or in a nutritive solution free from lime. Roots developed, sometimes one, sometimes two or three, on the cotyledons near the attachment to the axis. It was also found that roots, and less frequently shoots, would form on cotyledons separated from the axis, but it was not quite clear whether the shoots were auxiliary or not, in spite of the careful separation of the cotyledons.

British Ornithological Notes.

The column in Knowledge hitherto devoted to British Ornithological Notes, and conducted by Mr. Harry F. Witherby, will, we regret to say, be now discontinued. Mr. Witherby wishes us to convey his sincere regrets to our readers that this course has been found necessary, and that no longer notice could be given.

REVIEWS OF BOOKS.

"The Evolution of Earth Structure, with a theory of geomorphic changes." By T. Mellard Reade, F.G.S., F.R.I.B.A., A.M.I.C.E. Pp. xvi. + 342. (London: Longmans, Green, and Co., 1903; price 21s. net.) Mr. Mellard Reade, with his long experience as an architect and engineer, has never lost an opportunity of applying physical principles to the explanation of the structure of the earth. His well known thermal theory of the origin of mountain ranges is discussed in our geological text-books; and he has been a consistent believer in the adequacy of subsidence and elevation in explaining the main problems of our Pleistocene deposits. In the present work, he has not attempted a continuous argument, but has brought together a number of papers and experimental observations which bear upon the development of the present surface of the earth. Mr. Reade does not shrink from controversy, but his methods of inquiry are always sympathetic. He relies (p. 33) on fluctuations of temperature in the earth's crust in accounting for surface-movements, differences of specific gravity, and local increases or decreases of volume, being thereby set up in the outer layers. A diagram (plate 1) illustrates his views on the formation of laccolites and batholites, by the expansion and melting of portions of the igneous shell which underlies the sedimentary series. We do not understand the "5956 miles" which are marked on this plate near the centre of the earth, and we are tempted to suspect the whole, on account of its obvious simplification. The serious reader of this book will come to it, however, well prepared, and will probably accept Mr. Osmond Fisher's permanently liquid layer, quite as readily as Mr. Reade's "semi-plastic underlying shell." Having shown how the vertical uplift of continental platforms, and the vertical falling in of oceanic basins, may be brought about, the author considers the local wrinklings in these areas, such as have produced our mountain chains. He attributes the tangential creep (p. 45) to the transference of material by denudation from one place to another, promoting subsidence, heating of the lower layers, and lateral expansion, with consequent crumpling of the strata. But Mr. Reade urges, and we think very wisely, that the alleged permanence of continents and oceans does not rest on geological evidence, when we extend our view over a sufficient lapse of time. He emphasises the occurrence of considerable and even mountainous irregularities in the floors of our present oceans, and denies that the edge of the continental plateaux represents any marked break between continental and oceanic forms (p. 103). The scarp so often noticed is aptly compared to the outer end of an artificial embankment formed by tipping, the *débris* from the land being largely responsible for what are often styled "submerged platforms."

The experimental models, by which mountain-structure is made to arise in circular circumscribed areas, are of wide interest (pp. 131-215), and lead to some criticism of the views of Suess on the potency of differential subsidence to produce the oceanic depths and the high continental masses.

Chapter XIX., on Slaty-Cleavage, descends somewhat from geomorphology to petrology; the interesting details have been already published by the Liverpool Geological Society. The volume also contains a paper on the denudation of America, in which the relations of continents and oceans are again discussed: and a final and lucid statement of the case against those who have asserted the permanence of these larger features of our globe.

The geological reader and the librarian will not consider the price of Mr. Reade's book high, when once they have turned it over, and have noted the numerous original illustrations, which in themselves give it a permanent value.

Galileo: His Life and Work, by J. J. Fahie. (London: John Murray, Albemarle Street, W., 1903; 16s. net.) Mr. Fahie has succeeded in giving a very life-like and attractive picture of the great philosopher. His restless energy of investigation, his keenness of observation, his affection and generosity to his relatives and friends (many of whom were most undeserving), and the biting wit with which he attacked his enemies are brought vividly before us. The last named quality was his ruin, and, far more than any novelty or heresy in the doctrines he taught, brought upon him the bitter persecutions from which he suffered. His real crime was that he made his opponents a laughing-stock, and Pope Urban VIII. believed that he too had been "made game of." He had given Galileo an argument against the proof which Galileo considered the most cogent in establishing the motion of the earth round the sun. Galileo placed that argument in the mouth of Simplicio, the representative of the Ptolemaic philosophy in the great "Dialogue," and the Pope regarded this as equivalent to saying that he was a "simpleton." Curiously enough this same irrefragable proof—the argument from the tides—is untenable, so that the Pope's objection has been justified by the result, though his mode of reasoning was unscientific.

Galileo's attitude of mind towards science was quite different from that of his contemporaries. As a result of this, his life was one of brilliant scientific triumphs, but also of unceasing conflict and bitter suffering, relieved, however, until the last eight years of his life, by the touching and romantic devotion of his noble-hearted daughter, Virginia. His is a heroic figure, and it as a hero that Mr. Fahie has treated him; the one fault to be found with his portrayal of him being that, like the Aristotelians of Galileo's day, he will not allow that there can be any spots on his sun, for he supports Galileo where he least deserves support, namely in his refusal to allow any merit to rival and independent workers in the same fields, such as Lippershay, Scheiner, and Marius.

The Saltness of the Dead Sea.

Two causes, says Mr. William Ackroyd, in the report of the Palestine Exploration Fund, have been assigned to account for the saltness of the Dead Sea. The first of these is the accumulation of chlorides, which solvent denudation derives from the rocks of the Holy Land. The second explanation is that an arm of the Red Sea was cut off by the rising of Palestine in prehistoric ages, and in either or both cases the saltness would have been intensified by evaporation. There remains, however, to be taken into consideration a third cause—the atmospheric transportation of salt from the Mediterranean. This may not improbably be a more potent factor than either of the other two causes of the Dead Sea's saltness. The salt which the winds carry inland from the sea falls in rain and is carried back again to the sea; but in the case of an inland lake without outlet it remains for evaporation, so much so that in the case of a Pennine reservoir water equally salt with that of the Dead Sea would be produced by this means in a fraction of the time usually assigned to the Pleistocene Age. Taking specimens of the rocks on which Jerusalem is built as samples of the Palestine rocks, they are found to be limestones of various compositions, and with the one exception of Kakule limestone, which contains 0·025 per cent. of chlorine, or 0·041 of common salt, the chlorine contained in these rocks approximates to the general average of that found in the limestones of other countries of 0·01 per cent. This percentage would be quite inadequate to account for the salt in the Dead Sea, and the salt yielded to rivers by denudation is not a ninety-ninth part of that which has been supplied by rain water. Nor would the saltness of the Dead Sea be fully accounted for if a marine area had been cut off during the rising of the land, as the initial saltness thus acquired would only be about a fourth of that subsequently attained to; and, moreover, in this condition of saturation it has been for an unknown length of time continually precipitating its excess of salt. The intensity of meteorological conditions in the past geological history of Palestine have been much more severe than those now obtaining, and the atmospheric transportation of salt would be correspondingly greater. Some of the salt then accumulated has been left by the dwindling waters of the Dead Sea in areas to the north and south, notably in Jebel Usdum, and the highly brackish rivulets which come from these neighbourhoods now are but contributing again what long ago came from more distant sources.

The Nebulosities round γ Cygni.

By Dr. MAX WOLF, F.R.A.S.

I DISCOVERED these large nebulous masses in 1891, and on several occasions have published photographs of them. Some two and a half years ago I was fortunate enough to get a fairly good picture of them with my sixteen inches Brashear lens, which I hope may prove of interest to the readers of "KNOWLEDGE & SCIENTIFIC NEWS." The accompanying plate has been made from a contact print from the original photograph, which was exposed for nearly seven hours, on the nights of July 16 and 17, 1901.

The bright star involved in nebulosity in the centre of the plate is γ Cygni. The star, α Cygni, is not included in the plate, but would lie a little outside it, at the left upper corner. The nebulous stream running diagonally across the plate, in the line joining γ Cygni and α Cygni is very distinctly shown. But the most striking feature of this region is furnished by the broken nebulosities near the centre of the plate. The contrast, too, afforded by the crowds of stars and the nebulous masses is very remarkable. In some places all are mixed together, bright stars, small stars, and nebulosity; whilst in others the intervals between the stars are entirely free from nebulosity. Very striking, too, are the irregular dark holes in the nebulosity to the west of γ Cygni, and the clouds to the east, and north-west of that star. A curious straight line of stars crosses the plate north of the centre.

The scale of the plate is 32 millimetres to one degree of arc.

THE NEBULOSITIES ROUND γ CYGNI.

From a photograph taken by Dr. Max Wolf at Heidelberg, on July 16th and 17th, 1901.

The Ancestry of the Elephants.

By A. Smith Woodward, LL.D., F.R.S.

Long before the ancestry of the horses and camels had been discovered in North America, some of the immediate fore-runners of the elephants had been recognised and discussed in the Old World. The discoveries of Falconer and Cautley in India, of Falconer, Gaudry, and others in Europe, had made it evident that the elephant was derived by gradual stages from a more normal kind of quadruped. These gradations, however, could only be traced back as far as the Middle Miocene period, and no known animal of earlier date could be claimed as ancestral to the series. Lower Miocene and Eocene quadrupeds continued to be discovered in abundance, but never any trace of an elephantoid creature. The natural conclusion therefore was that the race of elephant-like animals only reached Europe and Asia in the early part of the Miocene period by migration from some other region in which the early stages of their tribal history were passed. It eventually became probable that the African continent would

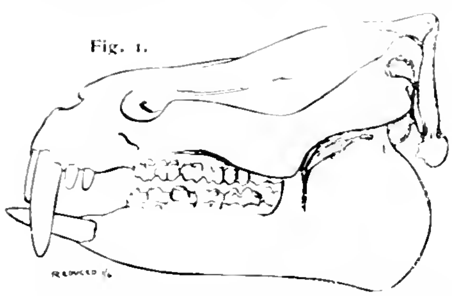


Fig. 1.—*Moeritherium lyonsi*: left side view of skull, upper view of mandible (A), and diagrammatic section of last molar tooth (B). Middle Eocene: Egypt.

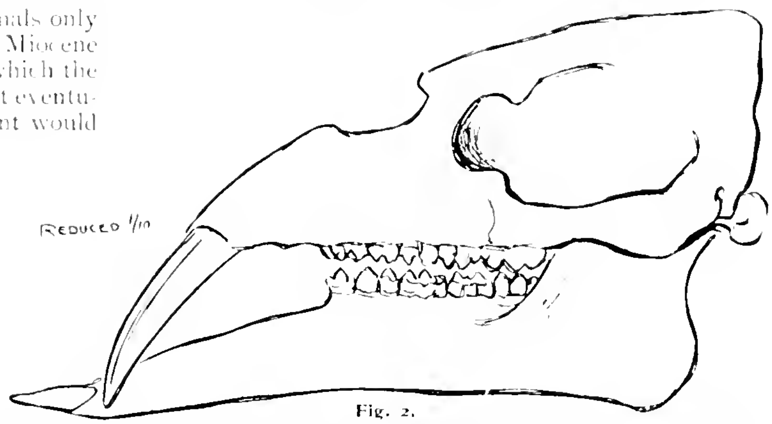


Fig. 2.—*Palaeomastodon beadnelli*: left side view of skull, upper view of mandible (A), and diagrammatic section of last molar tooth (B). Upper Eocene, Egypt.

yield these ancestors, and students of extinct animals began to look with confidence to that part of the world. Their expectations have not been disappointed: for the recently-published researches of Dr. Charles W. Andrews on early Tertiary Mammalia from Egypt* have furnished precisely the missing links that were desired. The evolution of the elephant-tribe is now almost as well known as that of the horses, camels, and their allies; and Africa is proved to have been its ancestral home.

The body of the elephant has changed very little during its long geological history. It has always retained the simple limbs with five toes and unaltered wrist and ankle. It has merely become a little shortened in proportion to its height, while the supporting limbs have grown in stoutness as the successive representatives of the tribe have increased in size and weight. In fact, it is permissible to describe the massive frame of a modern elephant as essentially an overgrown copy of the skeleton of a herbivorous quadruped of the early Eocene period.

All the features which make elephants unique among Mammalia are therefore to be observed in the head and neck. The story of their evolution is concerned mainly with the gradual enlargement of their tusks and complicated grinding teeth, and with the eventual growth of a peculiarly flexible, boneless, and prehensile prolongation of the face, which is commonly known as the proboscis or trunk. It is, in short, the story of a race which once fed in a normal manner on succulent weeds, browsing like any other herbivore, but afterwards began to subsist on drier or harder vegetation, and at the same time lost the power of reaching the ground with its mouth, depending for help on a modification of the snout which is elsewhere unknown.

The oldest recognised member of this race is the small *Moeritherium* (fig. 1) from the Middle Eocene of Egypt. It comprises species not much larger than the existing tapirs, and they possess a neck sufficiently long and flexible to have allowed them to browse in the ordinary way. The skull of *Moeritherium* shows that it did not support more than a rudimentary proboscis, but there are certain features in its structure which suggest a tendency towards arrangements now specially characteristic of the elephants proper. The teeth are disposed in a long series, and are nearly as numerous as in any of the early quadrupeds. In the upper jaw there are the usual three pairs of front cutting teeth or incisors, but the second pair is much larger than the others, and forms conspicuous downwardly-curved tusks. Small canines, or corner teeth, are also present; and there are six grinding teeth on either side (three pre-molars and three molars), most of them bearing two cross-ridges, the hindermost also with a third small posterior ridge (fig. 1B). The lower jaw (fig. 1A) likewise has six grinding teeth, of which the molars closely resemble those of the upper jaw; but canine teeth are absent, and there are only two pairs of incisors, the outer pair being much the larger. The jaws

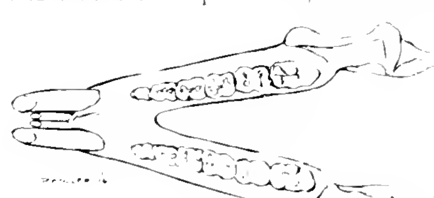
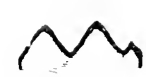


Fig. 1a.



Section 1b.

are narrow, but there is no conspicuous prolongation of the chin (or mandibular symphysis).

The next genus, from the Upper Eocene of Egypt, is much more clearly elephant-like. It is named *Palaeomastodon* (fig. 2), and comprises species somewhat more than twice as large as any of the earlier kinds of *Moeritherium*. A peculiar elongation of the skull and a long, spout-shaped growth of the bone of the chin (mandibular symphysis) are now very noticeable, and all the incisor teeth except one pair have disappeared above and below.

* "On the Evolution of the Proboscidea," Phil. Trans., 1903, pp. 99-118.

The surviving upper incisors are rather large tusks, and have lost all the enamel except a narrow band on one face—exactly like the front teeth of a gnawing animal (Rodent). The lower incisors are at the end of the chin far in front of the upper tusks, and they are still more like the incisors of a rodent (fig. 2A). They have a band of enamel on their lower face, and they are worn to a chisel-shaped edge by some opposing hard substance—

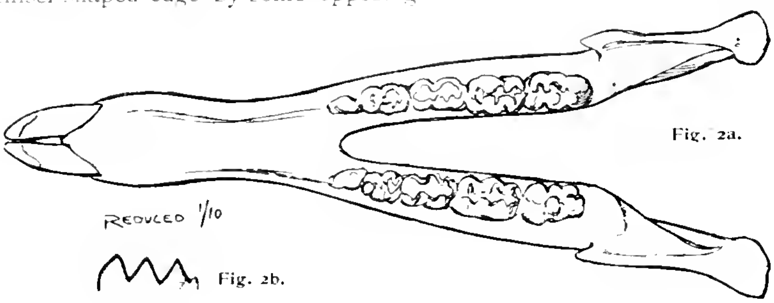


Fig. 2a.

Fig. 2b.

perhaps a pad on the palate. The grinding teeth of the upper jaw are as numerous as in *Moeritherium*, and those of the lower jaw are only reduced by the loss of another front pre-molar. The three molars, however, are relatively larger and more complicated than in the earlier genus, each bearing three cross-ridges, the hindermost also with a rudimentary fourth ridge (fig. 2B).

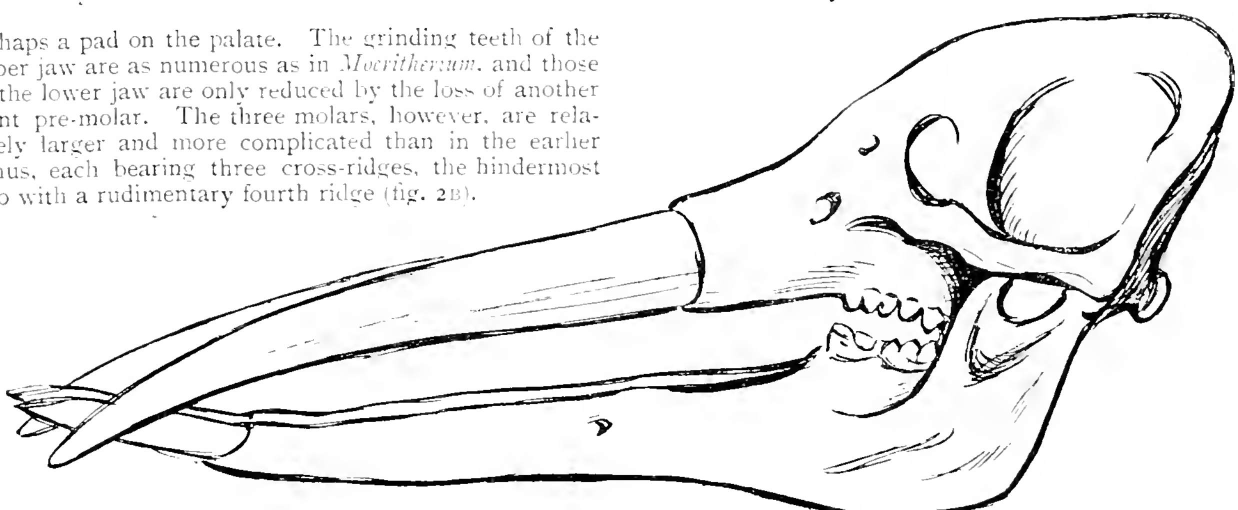


Fig. 3.

FIG. 3.—*Tetrabelodon angustidens*, left side-view of skull, upper view of mandible (A) and diagrammatic section of last molar tooth (B).—Middle Miocene; Europe.

The elephant-like quadrupeds continued to live in Africa from the Eocene period to the present day, but, probably through some re-arrangement of land and sea, they also wandered into Europe in the early part of the Miocene period, and soon afterwards penetrated even to the extreme eastern limits of Asia. The European and Indian members of the race during these later periods are indeed better known than those from Africa itself, and they must be referred to for information concerning the Miocene and Pliocene developments.

In the Middle Miocene, as shown by *Tetrabelodon angustidens* (fig. 3), the hinder part of the skull becomes short and deep, the upper tusks and their sockets are

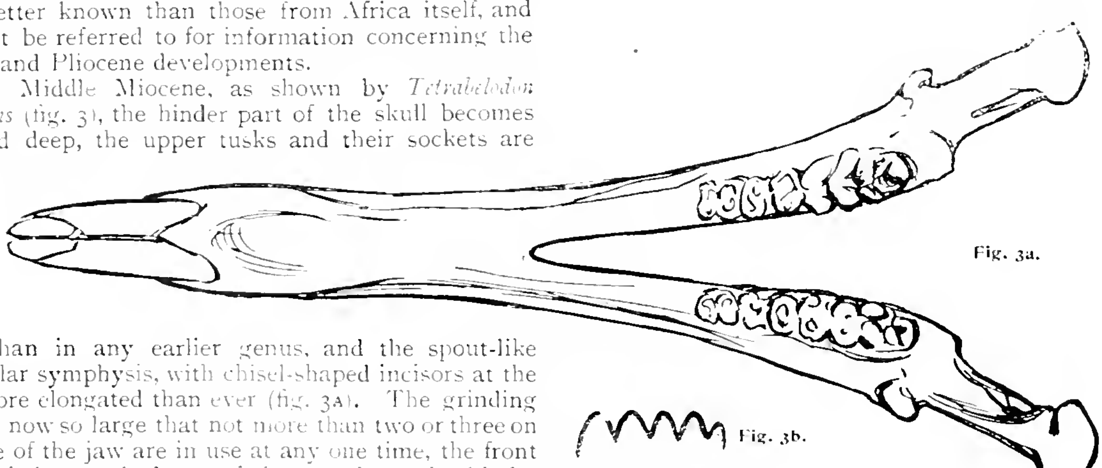


Fig. 3a.

Fig. 3b.

longer than in any earlier genus, and the spout-like mandibular symphysis, with chisel-shaped incisors at the tip, is more elongated than ever (fig. 3A). The grinding teeth are now so large that not more than two or three on each side of the jaw are in use at any one time, the front grinders being pushed out of the mouth as the hinder ones take their place: and these teeth exhibit greater complication than before, the posterior molar at least bearing four cross-ridges, with a rudiment of a fifth ridge (fig. 3B).

There is not much doubt that, with so remarkably elongated a head, *Tetrabelodon* would be able to browse on or near the ground, notwithstanding the length of its legs and the shortness of its neck. However, the shape of the skull shows that, even if the animal did not need a proboscis, the arrangement of the soft parts of its face and nose must have closely resembled this prehensile organ in a modern elephant. The outline of the head is, indeed, fancifully given in the accompanying fig. 6; and from this it is evident that the only hindrance to the use of the snout as a typical proboscis is the immensely elongated bony chin which underlies it.

Towards the close of the Miocene period many of the "mastodons," as these animals are generally termed, actually lost their bony chin by the shortening of the lower jaw. The soft snout being then destitute of support of any kind, must have begun to droop downwards: and there is thus no difficulty in understanding how it eventually became the essential feature of the modern elephants.

Some of the short-chinned species which form the genus

Mastodon of the Upper Miocene and Lower Pliocene periods in the Old World, of the Pliocene and Pleistocene periods in America, are provided with grinding teeth scarcely more complicated than those of the earlier *Tetrabelodon*. Their upper tusks also differ only from those of the latter in having lost the band of enamel

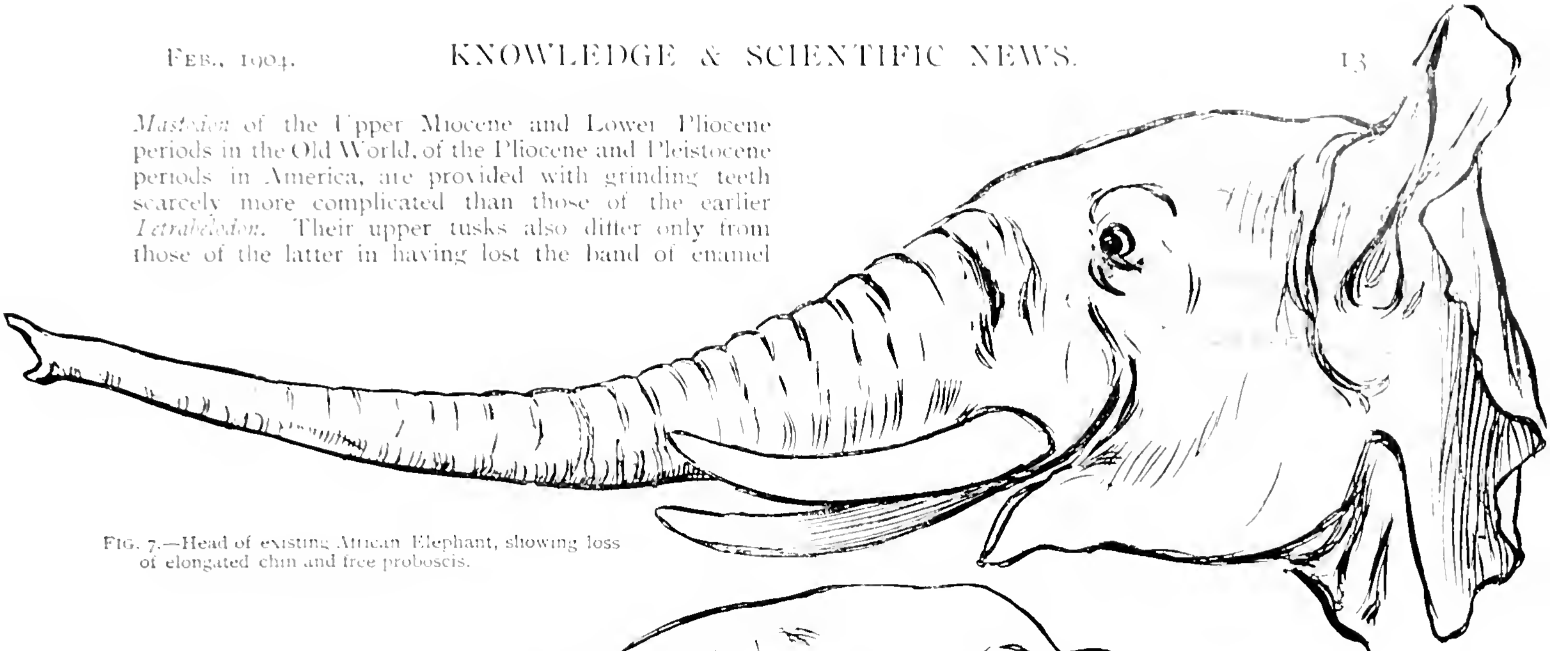


FIG. 7.—Head of existing African Elephant, showing loss of elongated chin and free proboscis.

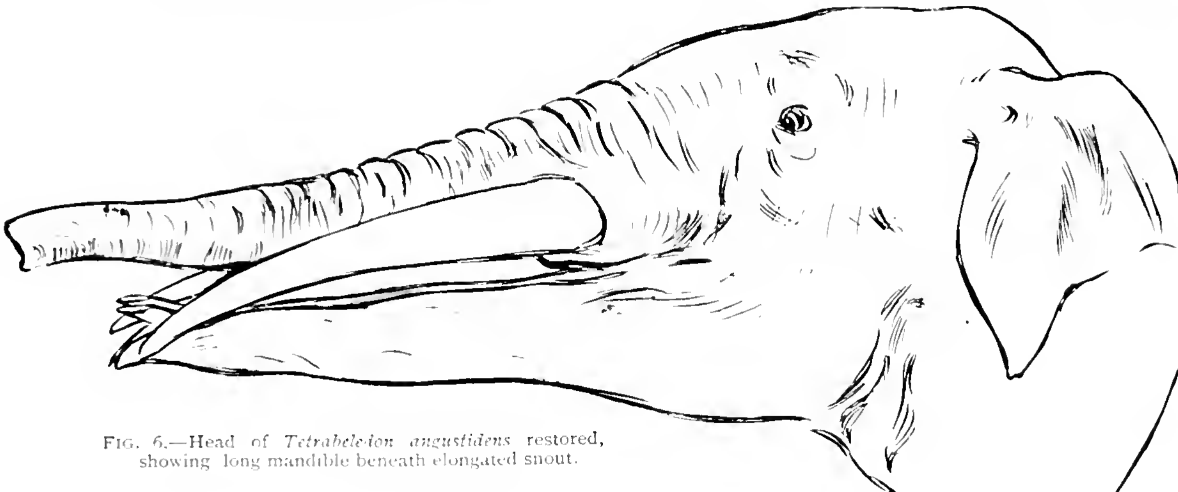


FIG. 6.—Head of *Tetrabelodon angustidens* restored, showing long mandible beneath elongated snout.

FIG. 5.—*Elephas primigenius*; left side-view of skull, upper view of mandible (A), and diagrammatic section of molar tooth (B.)—Pleistocene: Northern Hemisphere.

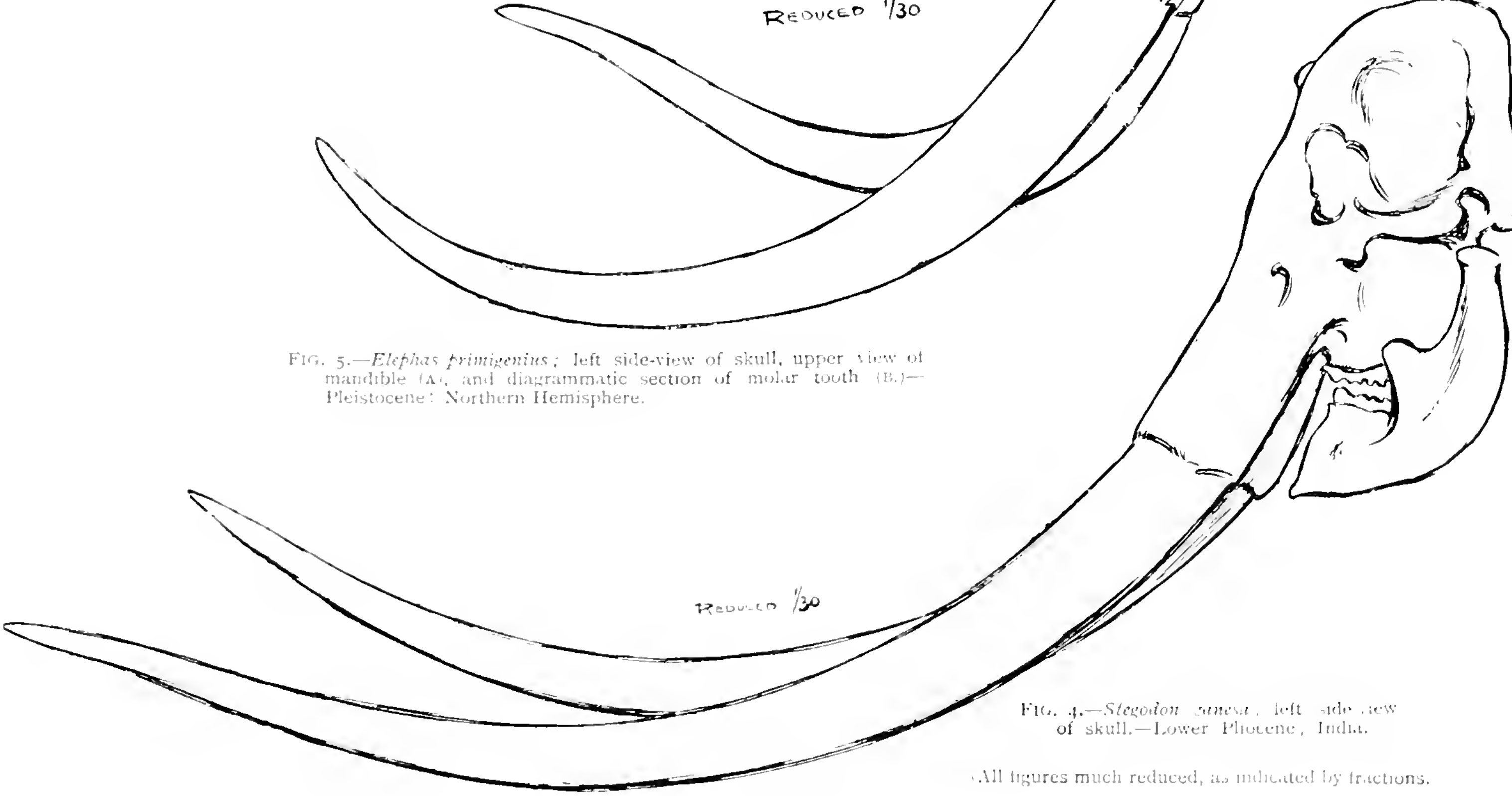


FIG. 4.—*Stegodon ganesa*; left side-view of skull.—Lower Pliocene, India.

(All figures much reduced, as indicated by fractions.

outside the ivory. Their lower tusks, however, are merely functionless rudiments, often lost when the animals are full grown.

At the same time it is interesting to observe, that as soon as the shortened chin and unsupported face had become characteristic of the "mastodons," true elephants with deep and ridged grinding teeth made their appearance at least in the Indian region, and quickly spread over all the Old World. The tusks of some species (fig. 4) now grew to immense size. The cross-ridges of the grinding teeth (fig. 5B) also became more numerous, and so much deepened and compressed that they might rather be described as plates: while the inconvenient crevices between them were filled for the first time with a third kind of tooth-substance, which is rather soft, termed cement. In the Lower Pliocene *Stegodon*, as the earliest true elephant is named, large grinding teeth, consisting of alternating cross-bands of hard and soft tooth-substance, were thus fully fashioned.

The later elephants and those of the present day only differ from each other in minor characters, and in the degree of compression or multiplication of the plates of their grinding teeth. The maximum complexity of tooth-

Fig. 5a.

Fig. 5b.

structure is reached in some of the hairy elephants, or mammoths (fig. 5) of the Pleistocene period, which ranged far north, even within the Arctic Circle, and may often have been compelled to feed on specially hard and dry vegetation. Their grinders (fig. 5B) are much deepened, capable of withstanding many years of wear in the mouth; and the numerous plates of which the posterior grinders are composed would hardly be recognised as simple tooth-ridges if all the initial stages in their evolution now described were not forthcoming.

The general conclusion, therefore, is that the history of the elephant is analogous to that of the other tribes of hoofed animals which culminated in the horses and the cattle. They have grown from mere creatures of the marshes to roam over the plains, or through forests, and have at the same time gradually acquired deeper and more effective grinding teeth. For some inexplicable reason, the lengthening of their legs with a concomitant shortening of their neck, necessitated a unique elongation of their face and chin to reach the ground for browsing. When this strange makeshift had reached its maximum degree, the chin suddenly shrivelled, leaving the flexible, toothless face without any support. By stages which we cannot discover, because they concern only soft parts which are never fossilised, this flexible face became the wonderful prehensile proboscis of the elephants as we know them to-day.

The Latest Discovery Concerning Cancer.

By J. T. CUNNINGHAM, M.A., F.Z.S.

WHENEVER a startling discovery is made in science the hope immediately arises that it may be applied to the cure of the most dreaded of human diseases. X-rays have been tried, and now physicians and patients are in despair because radium cannot be obtained with sufficient facility. But even if radio-activity is found to be capable of checking the malignant progress of cancerous growths, it is not likely to be more than a refined method of cauterisation, a merciful substitute for the surgeon's knife. No radical improvement in the treatment of the disease is probable until we know more of its nature and causes; still less is it possible without such knowledge to devise methods of prevention. The brilliant discoveries of recent years have shown that many of the most dangerous diseases are caused by infection, by the introduction into the human body of infinitesimal organisms of an animal or vegetable nature. Typhoid and tuberculosis, for example, are due to vegetable germs, malaria to minute active organisms belonging to the animal kingdom, and in the latter case the disease is only communicated by means of inoculation carried out by mosquitoes.

Numerous attempts have been made to prove that cancer is also a germ disease, but the latest researches tend to show that this view is erroneous. There is a certain amount of evidence that cancer may be to a certain degree infectious, but nothing to prove that the contagion is caused by the transmission of a living germ as in typhoid fever or malaria. The peculiarity of cancer among diseases is that it consists in the rebellion and malignant behaviour of certain parts of the body itself, not in the attacks of foreign enemies. Cancer in fact is a state of civil war in the body, a reign of terror produced by outbreaks of murderous fury on the part of licentious revolutionists at one or more localities.

The body is a complicated organisation of which the ultimate units are microscopic cells, each cell being a speck of living substance containing a central denser particle called the nucleus. The cells are of different shapes and sizes, and are united in various layers and masses which constitute the tissues, such as the muscular tissue, the bones, the brain and nerves, &c. Growth is due to cell-division, one cell dividing into two, and each of these two growing till it is again as large as the mother-cell, from which it was produced. The fertilised egg from which the body of any animal is developed is a single cell, and the development commences by the division of this cell into two, which divide into four and so on.

In this process of cell-division is manifested to the microscopist a regular series of changes in the nucleus. In its resting state the nucleus is a spherical structure containing a network of delicate threads. In division the spherical outline disappears and the network acquires the form of a convoluted continuous thread. This thread divides into a number of separate V-shaped loops, which are arranged on the finer lines of a spindle-shaped figure. Each loop divides along its length into two loops, and one half of each loop passes to one end of the spindle, the other to the other. This is the central event in cell-division, by which one group of nuclear loops forms two groups, and each of the latter forms a daughter-nucleus.

Now it is a curious fact that the number of these nuclear threads which appear at each cell-division is

constant in the same species of animal throughout life. The number may be 8, or 12, or 20, or 40, or some other number, but in the human body or that of any other animal the number is the same in each cell-division. To this statement, however, there is an exception. In the divisions which lead to the formation of reproductive cells, eggs or sperms, only half the usual number of loops is formed, and the division of these cells is of a peculiar type. The V-shaped chromosomes are replaced by loops and bends and rings, and these, also, range themselves in a different way. This is one of the most curious facts in microscopical science. Fertilisation consists in the complete union of the nuclei of two reproductive cells, and if the same number of nuclear loops were always formed, this number would be doubled in each generation, so that if we began with two we should go on to an infinite number. But as each reproductive cell has only half the proper number, the fertilised egg formed of two cells again has the proper number for the species.

Professor Farmer, of the Royal College of Science, with his colleagues, Mr. J. E. S. Moore and Mr. C. E.

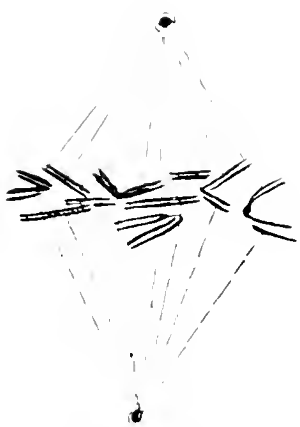


Fig. 1.—Diagram of a somatic division showing the split chromosomes, the halves of which form the daughter nuclei. The full number of the chromosomes is not shown.

Fig. 2.—Diagram of a heterotype division showing the characteristic rings and loops which split transversely to form the daughter elements. As in the preceding figure, the full number of chromosomes is not shown.

[Reproduced, by permission, from *The British Medical Journal*].

Walker, has made the remarkable discovery, which has just been communicated to the Royal and the Linnæan Societies, that these peculiarities in the division of reproductive cells occur also in cancer cells. The cancer is a mass of cells in a state of furious growth, and it invades and destroys the natural tissues all around it. The cells of the cancer show all stages of cell-division, and Professor Farmer finds in these stages the peculiarities which properly belong to reproductive cells only. In particular the number of nuclear loops is only half the number present in the cell-divisions of healthy tissue.

Professor Farmer is a botanist, and is distinguished for his researches in the microscopic structure of the cells of plants. It is a remarkable fact that in the processes of cell-division, reproduction, and fertilisation, the transformations seen in plant cells are essentially the same as in animal cells. The formation of the pollen of a flower in the stamens affords an example of the reduction of the number of the nuclear loops above mentioned to half the number proper for the plant. Only after the pollen nucleus has united with another in fertilisation is the full number regained. Again, a fern produces not seeds but spores. The nucleus of one of these spores contains only half the proper number of nuclear loops, and the divisions of the space which form the green flat growth preceding the development of the fern present the peculiarities which have now been observed in cancer. The theory suggested, therefore, is that cancer is the abnormal formation of reproductive tissue in parts of the body where no such tissue should be, or in certain case the abnormal behaviour of reproductive cells in their natural position; the peculiarities of such cells being associated with a tendency to rapid division.

The theory, if true, does not completely solve the problem. The question still remains, What are the causes of this outbreak of peculiar activity in the cells; how can we prevent it and guard against it? The most plausible suggestion at present is that some chemical compounds are produced in the body which stimulate and excite the cells to this insane and destructive fury, and we still have to discover whether this is true, and whether the stimulation can be prevented or stopped. It is something, however, to have more light on the nature of the disease, to be investigating in the right direction. Something is already known of the stimulation of cells to division by means of reagents, and it ought to be possible to discover some antidote to the tendency to division. Surgery is our only remedy at present, and is sometimes very successful; but there is always the possibility that the unknown causes may continue at work, and develop new centres of cancerous activity.

Zoological Notes.

By R. LYDEKKER.

Similarities of Elephants and Dugongs.

AT the conclusion of his memoir on the evolution of the Proboscidea, recently published in the *Philosophical Transactions*, Dr. C. W. Andrews directs attention to certain very remarkable resemblances existing between the elephants and their extinct allies (Proboscidea) on the one hand, and the manati and dugong (Sirenia) on the other. Among the features common to the two groups are the non-deciduate and zonary placenta, the abdominal testes, the pectoral position of the mammæ, the bifid apex of the heart, the general absence of a foramen in the lower end of the humerus, and a remarkable similarity not only in the form of the molars, but likewise in the mode of succession of these teeth, which are pushed forward in the jaws with advancing age. Whereas, however, in the Sirenia this pushing forward is due to the development of additional teeth at the back of the series, in the Proboscidea it is caused by a progressive increase in the size of the individual teeth from front to back. In both cases the anterior molars are shed as they become worn out. Other resemblances between the two groups exist. Although the evidence is far from being conclusive, yet it is strongly in favour of a relationship between sirenians and proboscideans, albeit at a very remote epoch.

Fossil Reptiles.

In a recent issue of the *Philosophical Transactions*, Mr. G. A. Boulenger describes some interesting reptilian remains from the Triassic sandstone of Lossiemouth, near Elgin. They include a remarkably fine skull of *Hyperodapedon*, which shows the structure of the palate better than in any other known specimen. The main difference from the corresponding aspect of the skull of the existing tuatera (*Sphenodon*) of New Zealand, apart

from the dentition, is to be found in the smaller bony roof of the mouth, and the narrower vomers. Another skull, which is made the type of a new genus and species, under the name of *Stenometopon taylori*, comes still nearer to the tuatera. Other specimens show that the reptile previously described as *Ornithosuchus* is not, as originally supposed, a dinosaur, but is more nearly related to *Phytosaurus* (*Belodon*), which latter Mr. Boulenger, like the author of the under-mentioned memoir, thinks should be removed from the Crocodilia to an order apart.

* * *

Classification of Reptiles.

An extremely important memoir on the classification of reptiles is published by Professor H. F. Osborn, in the *Memoirs* of the American Museum. Following the lead of certain other writers, the author proposes to divide reptiles into two main stems—Synapsida and Diapsida: the former including the primitive Cotylosauria, the mammal-like Anomodontia (exclusive of the American Pelycosauria), Chelonia (tortoises and turtles), and Sauropterygia (plesiosaurs), and the latter all the other groups. The one branch, it is urged, gave rise to mammals, and the other to birds. The main line of cleavage between the two branches is the single, or undivided, temporal arch (and the consequent presence of only one temporal vacuity) in the former, and the duplication of the same arch in the latter.

The divergence from the classification usually adopted in this country is not very great, if one factor be borne in mind. European writers usually classify animals according to their degree of evolution, while American naturalists prefer a phylogenetic scheme. That is to say, the former draw their lines of division horizontally, and the latter vertically. A case in point is afforded by the ancestry of the horse, treated in our last issue. American writers would include in the *Equidæ* all the members of the series down to and inclusive of *Hyracotherium*, whereas English naturalists place in that family only the really horse-like latter forms, while they would refer the earlier types to other families, among which would be embraced the ancestors of the tapirs and certain "non-adaptive" forms. Much may be said in favour of both schemes: which, instead of being opposed to one another, are in reality different aspects of the same view.

Duration of Pregnancy in the Badger.

It is not a little remarkable that there should still be great doubt in regard to such an apparently simple matter as the duration of pregnancy in the badger. A writer in the December number of the *Zoologist* considers that the period is about 12 months, whereas another observer had some time ago put it at about $4\frac{1}{2}$ months. Perhaps the true explanation may be that suggested in Sir H. Johnston's "British Mammals," namely, that the normal period is about six months, but that, as in the roe-deer, under certain circumstances, development may be so retarded as to make the time of gestation double that length.

*

Evolution of Marsupials.

An important memoir by Dr. B. A. Bensley, on the evolution of Australian marsupials, has just been published in the *Transactions* of the Linnæan Society. In regard to the origin of marsupials generally, the author is of opinion that the vestigiary placenter of the bandicoots has been independently acquired, and is not therefore indicative of descent from placentals. Nevertheless, he admits the comparatively near relationship of placentals and marsupials. The latter are believed to have been primarily differentiated by the assumption of arboreal habits, and the earliest forms that can be definitely assigned to the group are the opossums, which thus form the stock of all the modern types, with the possible exception of the Tasmanian wolf, or thylacine. This arboreal radiation distinguishes marsupials from the extinct creodonts, which were terrestrial. At the same time, the thylacine, which it is suggested may have been a foreign immigrant into Australia, appears to be related to certain middle tertiary South American types (*sparassodonts*), which may themselves be connected with the creodonts. How this fits in with the arboreal ancestry of the other marsupials is left unexplained.

That curious creature, the gigantic extinct *Thylacoleo* of Australia, originally regarded by Owen as carnivorous, but considered by Flower as herbivorous, is reaffirmed to be a flesh-eater.

As regards the date when marsupials first reached Australia, there has been much difference of opinion, Wallace giving it as Jurassic, Spencer as Cretaceous, and Lydekker as Eocene: the author considers that it did not take place till Miocene times. Whether the route traversed was *via* the Malay Archipelago and Papua, or by Antartica, is left undecided. There are many other points of interest in the memoir, to which lack of space forbids allusion.

Death of Prof. Karl von Zittel.

Palæontologists throughout the world will hear with deep regret of the death of Professor Karl von Zittel, which took place at Munich from heart-affection. Professor Zittel is most widely known by his splendid Manual of Palæontology, of which a smaller edition was published as a Handbook. The latter has been translated into French, and two volumes of an English (somewhat modified and expanded) edition have also appeared. Much original palæontological work was also accomplished by the late Professor.

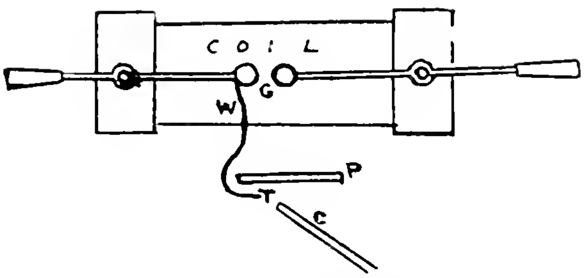
The Electric Eye.

Curious Experiments with Electric Sparks.

MR. WALTER J. TURNEY describes in the *Scientific American Supplement* some very interesting experiments showing results which he attributes to the ultra-violet rays of light. An ordinary half-inch Ruhmkorff coil has the knobs of its terminals so adjusted that sparking just fails to take place across the gap. On presenting a conductor to the inner side of either knob, vigorous sparking at once takes place and continues so long as the conductor remains, ceasing as soon as it is removed. If, however, a non-conductor be presented in the same way, a precise result, oddly enough, ensues. A piece of bare wire, W, about four inches long, was next attached to one of the knobs, and bent round as shown in the figure. If the conductor C be presented to the end, T, of the wire, continuous sparking will occur at the gap G. On now placing a screen, P, of cardboard, glass, or metal, so that G is invisible from T, sparking will cease, but will recommence so soon as the screen is removed. If, however, the screen be of rock-crystal, gypsum, rock-salt, or alum, the sparking will not be interrupted thereby. In another arrangement tried, a mirror was introduced to reflect the image of the junction on to the spark gap, with similar results, as though the spark could see what was going on.

A further modification was the introduction of a square

prism of rock salt, about three quarters of an inch wide, as a screen. First this was turned so that one face was perpendicular to the line joining T to G. On placing the conductor near to T, vigorous sparking commenced at G. If the prism be then turned so as to present an angle, the vigour of the sparking will be diminished, even though the prism be moved slightly to one side so that the line joining the points would only traverse a small thickness of the rock-salt. The exact explanation of these phenomena is not clear. It seems evident that



light, which can be impeded, reflected, or refracted, is the origin of the effects shown. That they are not caused by ordinary light, however, seems to be the case, since the plates (three-quarters of an inch thick) of rock-crystal, &c., interrupt the communication. The author concludes that rays of ultra-violet light are the cause of the phenomena. This seems a promising field for investigation, as the apparatus is so very simple and easily applied.

The Altimeter.

WE have received from Messrs. Newton and Co. a list of their optical and other scientific instruments. Among their novelties is the Altimeter, which has been made to supply a want that has been felt among kite flyers and military balloonists. It is a simple form of aneroid barometer marked in figures for heights, and is so devised that the hand on the dial rests at the highest altitude obtained by the kite or other aeronautical machine on which it has been sent up. The scale tends to five thousand feet, and the full-sized instrument in an aluminium case weighs about seven ounces. Messrs. Newton mindful of the increasing price of radium, which makes even a few milligrammes of the metal an expensive luxury, have produced a radium screen, which is a sheet of glass coated with a mixture containing radium bromide in very small quantities. The largest sized screens cost half a guinea, and there are cheaper ones which are sufficient for showing many of the remarkable properties of the metal.

IT is not to northern China that one would usually look for an example of electrical progress, but there is at least one place on the eastern shore of the Liaotung Peninsula which might well set an example to many of the western towns. We refer to the city of Dalny, which lies near Port Arthur, in that portion of the Chinese Empire which was leased to Russia in 1898. Electrically, Dalny is up-to-date. It has both telephones and the electric light. The central station, which is considered the finest electric plant in Asia east of Singapore, was finished over a year ago. It is equipped with three of Ganz and Co.'s generators, with a total of 1000-horse power, and has a reserve space for additional machines to double its present capacity when required. Dalny, besides other things, is an important seaport, and has a dry dock 350 feet long, 50 feet wide, and 18 feet deep, which is equipped throughout with electric pumps. A larger dry dock is building, at which electricity will also be adopted. In connection with the dry dock are the harbour repair shops, with foundry, smithy, machine and fitting shop, boiler shop, etc. All these shops are electrically driven and lighted throughout. Dalny also boasts an excellent telephone service, and altogether it may fairly claim to be one of the most progressive cities in the East.

Continental Physical Notes.

By DR. ALFRED GRADENWITZ.

Researches in Solar and Stellar Photometry.

THE accurate data we possess as to the ratio between the intensity of the different stars are due to the work of several generations of astronomers. As regards, however, the ratio between the intensity of the sun and that of the stars, the results are far from being as satisfactory, the figures stated by different observers varying up to ratios as high as 1 and 10.

The knowledge of these ratios, as pointed out by Ch. Fabry (Eclair. Elec. No. 50), is, however, of the highest interest, allowing as it would of determining for stars the distance of which from the earth is given the ratio between their absolute candle power and that of the sun, and thus of classifying the sun, so to say, in the hierarchy of the stars.

As the light of the sun has a colour resembling closely that of most of the stars, a photometric standard of the same shade could be chosen, which is far from being the case in connection with our ordinary lamps. To this effect, Fabry projected the light of a glow lamp through a layer of an ammoniacal solution of copper sulphate; by regulating either the thickness or the concentration of the liquid layer, the emerging light could be given a tint strictly identical with that of the light of the sun. The photometric standard thus modified would be compared separately, both with the light of the sun and that of a star when the ratio $\frac{\text{Sun}}{\text{Wega}}$ was found to be about 6×10^{10}.

As regards the data relative to the illumination produced by stars in terms of our photometric standards, the results obtained are true only to within 10 per cent., on account of the difficulty inherent in the difference of coloration. According to Fabry, the illumination produced by the sun when in the zenith on the level of the sea is about 120·000 lux, being, as a matter of course, variable with atmospheric conditions, but to a smaller extent than might be anticipated, provided that only days of fine weather be considered. Photometric measurements will allow of ascertaining whether the sun is a variable star.

These researches will enable the photometric unit of astronomy to be connected to that of physicists. The intensity of a star should be measured by the illumination produced on a surface perpendicular to its rays, being expressed in lux. On the other hand, astronomers will define the same by its *magnitude*, the magnitudes of two stars differing by one unit, as the ratio of their intensities is 2 : 5, the most brilliant having the smaller magnitude. The following table records some comparative data of this kind :—

Star.	Magnitude.	Illumination in Lux.
Sun	− 26·6 ..	120·000
Moon	12·2 ..	0·2
Star first magnitude	+ 1 ..	$1·05 \times 10^{-6}$
Star sixth magnitude	+ 6 ..	$9·7 \times 10^{-9}$
Star fourteenth magnitude ..	+ 14 ..	$6·6 \times 10^{-12}$

As the most feeble stars visible to the naked eye are those of the sixth magnitude, one candle ceases to be visible to the naked eye at a distance of about 10 km., and a telescope showing stars of the fourteenth magnitude would allow of seeing a candle at a distance of 400 km. (apart from atmospheric absorption).

Electric Discharges in the Air.

IN a paper read before the Angers Congress of the French Association for the Advancement of Sciences, Professor de Kowalski describes some experiments made by him, in conjunction with Mr. Moscicki, on the chemical action of high frequency electric discharges in gaseous mixture. With a certain frequency, a discharge through a gaseous medium is found to take a special character, which, by the way, depends also on the amount of electric energy available. The chemical actions of a similar discharge are very important from the

point of view of practical application, as in air an abundant production of nitrous vapors is observed; whereas in mixtures of carbonic gas and nitrogen both nitrous vapours and carbon monoxide are produced; with a mixture of benzine and nitrogen vapours, cyanogen and hydrogen will be obtained. On account of the importance of the problem in practice, Kowalski and Mosciki have especially dealt with the production of nitric vapours and hence nitric acid. They were able to obtain up to 44 grams of nitric acid per kw. hour, it appearing from their calculations that the price of one kg. of calcium nitrate would not be upwards of 1½d.

De Kowalski next describes some experiments made on electric discharges on the surface of insulating bodies. As one side of the insulating plate is covered with a conductive layer while discharges are being produced on the other, sparks very much longer than without a conductive layer are obtained. Photographs presented by the author show the sparks to follow accurately the way drawn by conductive layer on the side of the plate opposite to the discharge, it being thus possible to obtain sparks of a triangular, square, zigzag, &c., shape. The author finally points out the analogies shown by the discharges with those produced in the atmosphere during thunderstorms.

On some Novel Phenomena in connection with N-Rays.

Professor Blondlot actively continues his investigations of N-rays, and in a paper recently read before the French Academy of Sciences we note some interesting facts. The author has some time ago observed that sources of light would, under the action of N-rays, show an increase in brilliancy. Now Blondlot thought it interesting to test whether the same phenomenon takes place in the case of a body reflecting the light from an external source being employed instead of an illuminant proper. The following experiment was accordingly made: A ribbon of white paper, 15 mm. in length and 2 mm. in breadth, was fixed vertically to an iron wire support: the room being darkened, the paper ribbon would be feebly illuminated by projecting on the same, laterally, a beam of light given off from a small plane enclosed in a box where a vertical slit was provided. The N-rays from an Auer burner, traversing a rectangular slit in front of the above slit, would strike the paper ribbon. Now, if the rays were intercepted by interposing either the hand or a lead plate, the small paper rectangle would be darkened and its outline lose in distinctness; as soon as the screen was taken away again both the brilliancy and distinctness would reappear, this giving evidence of the light diffused by the paper ribbon being increased under the action of N-rays.

Now, the diffusion of light is a complex phenomenon, where regular reflection plays the part of an elementary fact. The author therefore thought of investigating whether the reflection of light is also modified under the action of N-rays. To this effect, a polished knitting needle of steel was placed vertically in the position formerly occupied by the paper ribbon; in a box completely closed but for a vertical slit at the height of an Auer lamp (shut by a screen of transparent paper), a flame was placed so as to illuminate the slit. When adjusting conveniently the eye in the slit, the image of the latter formed by reflection on the steel cylinder was distinctly seen; while the reflecting surface was struck by N-rays, when the action of the ray proved to strengthen the image. Similar results were obtained, replacing the needle either by a plain bronze mirror or a polished quartz surface. All these actions of N-rays require an appreciable time both to be produced and to disappear. On the other hand, no action of N-rays on refracted light could be observed, though various experiments in this direction were undertaken under many different conditions.

As the capacity of seizing small variations in candle power is rather different for different persons, these phenomena are nearly at the limit of perceptibility to some persons, who, only after a certain practice, will be able to seize them regularly and to observe them safely, whereas others will at once, and without the least difficulty, note the strengthening effect of N-rays on the candle power of a small illuminant. Now, as the author has recently observed the same phenomena, with considerably increased intensity, when replacing the Auer burner by a Nernst lamp, these phenomena may now be produced with such intensity as to be visible to anybody.

The Printing Telegraph

The Berlin Teletyping Central Station.

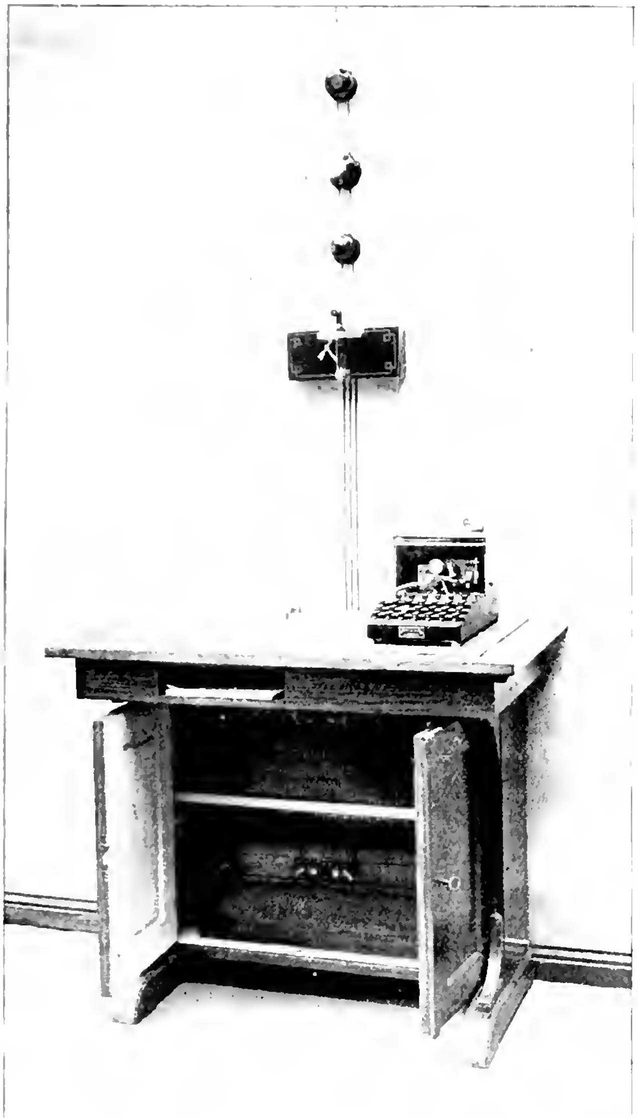
Telephones, rendering only words as they are spoken, are frequently insufficient for business purposes; in addition to a correct transmission of a communication, there will in many cases be necessary an acknowledgment in writing of this transmission. On the other hand, there is the liability of telephonic conversation to be overheard by a third person, and finally the person rung up on the telephone may happen to be absent, when his return will have to be waited for, and much time be lost. In order to afford an efficient means of communication in all these and many other cases, a new public printing telegraph service was installed in Berlin on Oct. 1st, when the "Ferndrucker Centrale" was opened to public service.

The telegraph, as constructed by the Siemens and Halske Company, is a type-printing telegraph similar to the well-known Hughes type printer and the Baudot telegraph. The main distinctive feature from former apparatus is, however, the fact that the latter moving freely, the simultaneous working of the instruments established on the same line had to be obtained by the skill of the operator, whereas the operation of the new apparatus is as simple as that of an ordinary typewriter. The apparatus, in fact, is nothing else than a teletypewriter, any letters, figures, or signs of punctuation being printed by pressing down a key corresponding with the signal in question. There are two circles of signs on the periphery of the type wheel, one comprising the letters and the other the figures and signs of punctuation. A shift key serves to adjust the type-wheel either for letters or figures. Both sets of apparatus, connected by a line, may be used either as sender or as receiver, without any special preparation being necessary, as soon as a special white key is struck; the apparatus in question is in fact made to serve as sender, and all will be ready for use. The printing takes place simultaneously in both the transmitting and receiving apparatus, no matter whether there is or is not somebody operating the receiving apparatus. In the case of the owner of the apparatus being absent, he will read the telegram printed on the paper ribbon on his return. The new telegraph, giving two identical records of the same telegram in the sending and receiving apparatus respectively, will place at the disposal of the transmitter an evidence of the correctness of his communication, so as to exclude any possibility of misunderstanding.

The advantages afforded by the printing telegraph, as compared both with telephone and present telegraph system, will be self-evident. Like the telephone, the new telegraph may serve for a direct communication between any two persons over any distances, but for its being free from any possibility of hearing mistakes or other misunderstanding, in virtue of the double simultaneous reproduction in printing of each communication. At the same time, there is, as above stated, no danger of a third person overhearing the communications. This is therefore the only means of communication enabling despatches *to be kept strictly private.*

A central station with arrangements and working methods similar to those of central telephone stations has been opened in 28, Zimmerstrasse, Berlin, serving in the first place to secure mutual communication between all the subscribers connected to the Berlin printing telegraph net. The central station is fitted with a switchboard comprising indicators and cathices for one hundred sub-

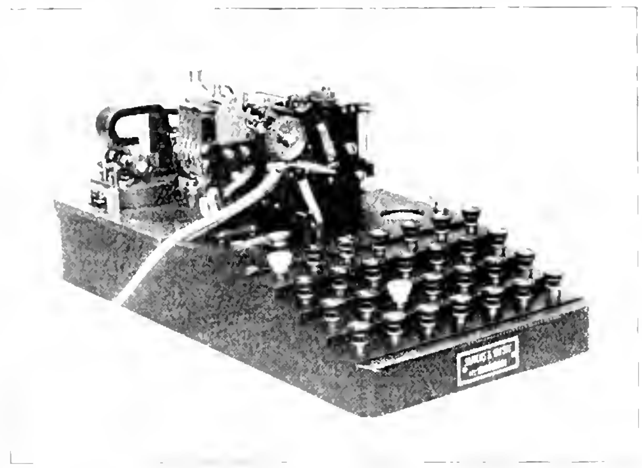
scribers. Sixteen connecting strings allow of 32 subscribers being simultaneously connected so as to enable a simultaneous communication between one third of all the subscribers in the case of the switchboard being complete. As soon as a subscriber presses down the calling key of his printing telegraph, the official in charge of the indicator board at the central station will be advised by the indicator of the subscriber in question dropping and an alarum being rung, when he will have to put himself in communication with the caller, to ask him for the desired connection through a special enquiring apparatus, and connect both subscribers so that their apparatus are



ready for immediate mutual communication. There is, however, in addition, the possibility of connecting any desired number of subscribers to the same printing telegraph so as to transmit the same communication simultaneously to all the subscribers. This is ensured by the subscribers who, as a rule, are connected to the indicator board of the central station, being disconnected from the latter and connected to the transmitting apparatus in question by means of a group switch.

Similar telegraphic services from one central station to a certain number of subscribers simultaneously, by means of a so-called ticker, have for some time been used in New York, London, and Paris. A similar service has been in operation also in Bremerhaven, Germany, for transmitting ship telegrams from one central station to 100 subscribers in different places. It is intended, from the central station just opened in Berlin, to transmit similar information to a certain number of subscribers, limiting the service at first to Exchange telegrams, which are transmitted at given hours from the transmitting apparatus in the Berlin Exchange. The same means of communication could be employed for transmitting telegrams from a central telegraph office, such as Reuter's, to a certain number of newspaper offices. In addition, the above central station is intended to secure communication of the subscribers with the central State telegraph office for transmitting or receiving telegrams through the State telegraph, for which subscribers are charged a rather low extra fee of so much per word.

The main feature will, however, be the *direct mutual communication* between the subscribers, and in this respect Berlin may boast of having quite a unique means of communication. The system has, by the way, been in operation for some time with great industrial concerns such as the Berlin Allgemeine Elektricitats Gesellschaft and the Siemens and Halske Company for communication between their various business departments.



In addition to the type-printing telegraph used in connection with the teletyping service described in another note, the Siemens and Halske Company have just brought out another kind of printing telegraph, intended for rapid service. The apparatus is analogous to the so-called automatical telegraph, where an apparatus similar to a typewriter pierces for each letter to be telegraphed certain holes in a continuous paper ribbon. The latter, on being drawn along through the rotating telegraphic sender, will throw automatically corresponding currents into the line. As the Siemens apparatus is capable of telegraphing 2,000 letters per minute, the telegrams transmitted by a large number of officials will be sent on the same wire. Two holes are pierced for each letter, the letter itself being printed immediately above in plain ordinary printing characters. The perforating may even be effected by the public itself. A disc, where the various letters are cut out as in a pattern, rotates at a speed of 2,000 revolutions per minute, between a spark gap and a continuous ribbon of photographic paper. Whenever a spark passes in the gap, a silhouette of the letter happening to be in front of the gap will be projected on the paper ribbon, which on running through sponges impregnated with developing and fixing liquids, will complete the photographic process.

A. G.

The Face of the Sky for February.

By W. SHACKLETON, F.R.A.S.

THE Sun.—On the 1st the sun rises at 7.43, and sets at 4.45: on the 29th he rises at 6.50. and sets at 5.36. The sun is after the clock, the equation of time reaching a maximum of 14 m. 25 s. on the 12th.

Sun spots may frequently be observed; of late, the solar disc has rarely been devoid of spots. For determining spot positions the appended table should prove useful

Date.	Axis inclined to W. from N point	Centre of disc, S of Sun's equator.
Feb 5 ..	13° 38′	6° 21′
,, 15 ..	17° 20′	6° 52′
,, 25 ..	20° 28′	7° 10′

THE MOON :—

	Phases.	H. M.
Feb 1 ..	○ Full Moon	4 33 p.m.
,, 8 ..	◑ Last Quarter	9 56 a m
,, 16 ..	● New Moon	11 5 a m.
,, 24 ..	◐ First Quarter	11 9 a.m

The Moon is in perigee and apogee at midnight on the 1st and 15th respectively. Occultations.—It will be seen from the particulars below that there is the interesting phenomenon of an occultation of the 1st magnitude star Aldebaran, and, moreover, the circumstances are most favourable as the moon is near the meridian.

Date	Star's Name	Magnitude.	Disappearance.	Reappearance	Moon's Age.	Moon Souths.
					D. H.	
Feb. 24	Aldebaran	1·1	5.57 p m.	7.15 p.m.	8 7	6.17p.m
,, 29	o Leonis	3·8	8.53 p m.	9.46 p.m.	13 10	11 6 p.m

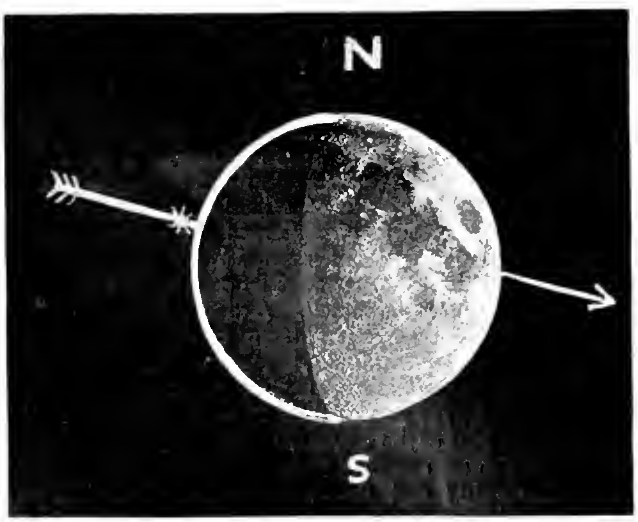


Diagram Illustrating Occultation of Aldebaran.

THE PLANETS.—Mercury is a morning star in Sagittarius: on the 10th, when he is at greatest westerly elongation, he rises 1 hr. 10 min. in advance of the sun.

Venus is a morning star, rising throughout the month about 5.40 a.m.; she continues to diminish in brightness and is becoming more gibbous, about 0·80 of the disc being illuminated.

Mars continues to be feebly visible in the south-west shortly after sunset; throughout the month he sets about 7.30 p.m.

Jupiter is rapidly getting more to the west and also diminishing in brightness; on the first he sets at 7.27 p.m., and on the 29th at 7.40 p.m. About the middle of the month his polar and equatorial diameters are 32″·4 and 34″·6 respectively.

The configurations of the satellites as seen in an inverting telescope, and observing at 6.30 p.m., are as follows :—

Day.	West. East.	Day.	West. East.
1	1 ⊙ 34	16	24 ○ 13
2	2 ○ 134	17	1 ○ 43 ●
3	○ 234 ●	18	⊙ 324
4	1 ○ 324	19	32 ○ 14
5	32 ○ 14	20	321 ○ 4
6	31 ○ 24	21	3 ○ 124
7	3 ○ 1$\frac{4}{2}$	22	13 ○ 24
8	1 ⊙ 23	33	2 ○ 134
9	42 ○ 13	24	12 ○ 43
10	4 ○ 23 ●	25	4 ○ 1$\frac{3}{2}$
11	41 ○ 32	26	432 ○ ●
12	432 ○ 1	27	4321 ○
13	4321 ○	28	43 ○ $\frac{2}{1}$
14	43 ○ 12	29	413 ○ 2
15	41 ○ 2 ●		

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Saturn is in conjunction with the sun on the 1st, and therefore unobservable.

Uranus rises only a short time before sunrise; this, together with his extreme southerly declination, makes him most unsuitable for observation.

Neptune souths at 9.30 p.m. on the 1st, and at 7.30 p.m. on the 29th. He is about half a degree S.E. of μ Geminorum and his path is shown in the chart given in the January number.

Meteor Showers :—

Date.	Radiant. R A.	Radiant. Dec.	Radiant. Near to.	Characteristics.
Feb. 5-10	75	+ 41″	η Aurigae	Slow; bright.
,, 15	236	+ 11″	α Serpentis	Swift; streaks.
,, 20	181	+ 34″	Cor Caroli	Swift; bright.

THE STARS.—The positions of the principal constellations near the middle of the month at 9 p.m. are as follows :—

ZENITH . Auriga.

SOUTH . Orion, Gemini, *Procyon*, *Sirius*, Cetus, Pleiades, Taurus to the S.W., Cancer and Hydra to the S.E.

WEST . Andromeda, Aries, Pisces, with Pegasus and Cygnus to the N.W.

EAST . Leo, Virgo.

NORTH . Ursa Minor, Draco, Cepheus, Ursa Major to the right of Polaris.

Minima of Algol may be observed on the 1st at 11.52 p.m., 4th at 8.41 p.m., 7th at 5.30 p.m., 22nd at 1.35 a.m., 24th at 10.24 p.m., and the 27th at 7.13 p.m.

Telescopic Objects:

Clusters. M35, situated about 2° N.E. of η Geminorum or about midway between ζ Tauri and η Geminorum. Fairly compact, presenting a beautiful appearance of star streams when observed under favourable conditions. R.A. VI.^{h} 3^{m} Dec. N. 24° 21′. M41, about 4° directly south of Sirius; visible to naked eye; Messier registered this group as "a mass of small stars." R.A. VI.^{h} 43^{m} Dec. S. 20° 38′. M44, the Præsepe in Cancer, visible to the naked eye as a nebulous patch, best seen and easily resolvable with a pair of opera or field glasses. On account of the scattered nature of the group the cluster effect is lost when observed through a telescope unless very low powers be employed. Situated a little to the west and about midway of the line joining α and δ Cancri. R.A. VIII.^{h} 34^{m} Dec. N. 20° 20′.

Double Stars. *Castor*, separation 5"·8, mags. 2·7, 3·7. Excellent object for small telescopes. The brightest pair to be observed in this country; can always be relied upon as a good show object.

κ Geminorum, separation 6"·3, mags. 4, 8·5; very pretty double.

ζ Cancri, separation 1"·1, 5"·3, mags. 5·0, 5·7, 5·5; with small telescopes the wider component is readily seen.

ν Draconis, separation 61"·7, mags. 4·6, 4·6; a pretty and easy double, can be separated by observing with a pair of opera glasses.

The Shower of November Leonids in 1903.

To the Editors of "Knowledge."

Gentlemen,—At the end of my paper under this heading, published in the January number of "Knowledge," I referred to a second magnitude meteor seen at 15 hrs. 59 mins. on November 15, and moving in a long and slowly traversed path from a probable radiant at 113° − 34°. Two of the observations from which the real course was deduced were, however, somewhat imperfect and indefinite. Fortunately I have since received a description of the object as seen at Greenwich at 15 hrs. 59 mins. 38 secs., and I have recomputed the heights and radiant. The latter position was really in Hydra at about 147° − 11°, and the height of the meteor varied from 91 to 45 miles during its extended flight of 128 miles, which it pursued at the rate of 29 miles per second. The object certainly travelled at a much slower speed than is consistent with a parabolic orbit.

Professor Herschel has recently been comparing the recorded paths observed on the night of November 15 by several observers, and has found a few interesting accordances. Two of these were of brilliant Leonids, and the real courses which I have calculated for these agree very closely with the results previously obtained by Professor Herschel, and are as follows:—

Date and Greenwich mean time of the observations..	November 15 10 hrs 45½ mins	November 15 18 hrs 7 mins.
Estimated magnitudes	4 — ♀	>1 — 4
Radiant point	151° + 25°	151° + 23°
Height at beginning ..	77 miles	81 miles
Height at ending	52 ,,	60 ,,
Length of visible path ..	30 ,,	24 ,,
Velocity per second.. ..	60 ,,	44 ,,
Observers	A. S. Herschel, Slough W. F. D., Bristol	A. S. Herschel, Slough. A. King, Sheffield W. F. D., Bristol

Notwithstanding the richness of the Leonid shower in 1903, and the large number of observations, comparatively few of the same meteors appear to have been seen at two stations.

Bishopston, Bristol,
January 6, 1904.

Yours faithfully,
W. F. Denning.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Magnification of Objectives and Eyepieces

It is scarcely necessary to explain to any worker with the microscope that, whereas a simple lens gives a single magnification only, the essential principle of the compound microscope is that the image formed by the first lens or system of lenses, called the objective, is itself again magnified by a second lens or system of lenses known as the eyepiece, or ocular. But, simple as this is in principle, the means by which it is brought about, and the various points connected therewith, are often not fully understood by ordinary workers, many of whom are not clear as to the exact meaning of such terms as one inch, half-inch, &c., as applied to objectives, or to references to angular aperture as compared with numerical aperture, aplanatic aperture, &c.

Briefly, the principle on which objectives are rated is as follows: We have here a lens, or system of lenses, with which we form our first magnified image, and this image is formed at a definite distance from the back of the lens. According to English standards, this distance is 10 inches, which was originally adopted as being the the normal visual distance of the human eye. Then it follows that the relative size of object and image will vary directly as their respective distances from the lens, or rather from its centre. Accordingly, if the two distances are 1 inch and 10 inches respectively, the initial magnification will be ten times, and here we have our 1-inch objective. If the distances are 2 inches and 10 inches, the magnification will be five times, and the objective will be known as a 2-inch. If the distances or foci are ½ inch and 10 inches, the magnification will be twenty times, and the objective is ½ inch, whilst a 1-12th inch objective magnifies initially 120 times.

On the Continent, however, the image comes to a focus about 6½ inches behind the objective, this being the Continental tube-length, but the rating seems to generally remain the same—the 1-inch magnifying 10 times at 10 inches, the 2-inch 5 times, and so on. Thus a Continental 1-inch objective used with a 6½-inch tube should only give an initial magnification at this distance of 6·5 diameters. As a matter of fact, however, objectives are nearly always overrated, sometimes absurdly so, and therefore a Continental 1-inch may give an initial magnification exceeding 10, even with the short tube.

Of course the tube-length of a microscope can generally be varied, and the result will be in the first place a readjustment of focus and a consequent variation in the magnification. But the second result is that, as objectives are not meant to be used for uncovered objects, they have been carefully "corrected" for a certain definite thickness of cover-glass. The Royal Microscopical Society has used its powerful influence to bring makers into line throughout the world with regard to the standardizing of the screw of objectives, the diameters of eyepieces, and the size of sub-stage condensers, and it would be a great advantage if it could also standardize the thickness of cover-glass to which objectives are corrected. Perhaps this may be done some day; in the meantime

each maker, whether English or foreign, is a law unto himself, and the list of cover-glass corrections is a most formidable one. But it follows that any variation in cover-glass thickness from that for which the objective was originally corrected necessitates a readjustment either of the lenses of the objective, by means of a "correction collar," or by adjustment of the length of the microscope tube. In the latter case, of course, we have at once a variation of initial magnifying power, but the converse also applies, *i.e.*, that an arbitrary variation of tube-length affects the corrections, and consequently the performance of the objective. We can at once see the limitations, therefore, of the ordinary suggestions as to varying the magnification by drawing out or pushing in the draw-tube of the microscope. With low powers of small angle the difference in performance is not marked, and would even need a trained eye to detect it, but it becomes more and more marked with an increase of angular aperture, which generally coincides with higher powered objectives. Broadly speaking, therefore, we must use our objectives with the tube-length for which they were originally constructed.

The part played by the ocular—at least by the Huyghenian type of ocular which is generally used and with which we need only concern ourselves here—is twofold. It consists of a field-lens and an eye-lens, with a diaphragm between. The field-lens may really be considered almost as part of the objective, for its action is to draw in the image rays and bring them to their final focus in the plane of the diaphragm just mentioned. Then the eye-lens merely magnifies this image and brings it to a focus suitable for the eye.

It is important to note, therefore, that the magnification of any unadjustable ocular is always a fixed quantity, but that the magnification of an objective (perfection of image apart) will vary according to the tube-length. In spite of this, many Continental and some English makers persist in treating the two magnifications as if it were the ocular magnification which varied, thus giving rise to no little confusion. I have seen lists in which elaborate tables have been made of the combined magnifications of objectives and oculars used with a $6\frac{1}{2}$ inch tube, in which the ocular has been treated as the varying quantity, and I have seen calculations of magnifications of objectives in one and the same table in which an inch or other objective is treated as magnifying 10 times and in another 7 times, at $6\frac{1}{2}$ inches distance, the real fact being that the oculars are not of the powers they profess to be. All this is, of course, very confusing to the beginner.

Now, focuses do not represent "working distance." This merely represents the clear space between the cover-glass and the front surface of the objective, and can be measured by a carefully made wedge of wood which is inserted when the objective is focussed, marked, and then measured.

Nor is it necessary for us to work out with mathematical accuracy the exact equivalent foci of objectives, which are made up of complicated systems of lenses. This would be a difficult matter. It will be sufficient for us to obtain the approximate equivalent focus—approximate because the centre of the system cannot be readily obtained. If we set up conjugate foci at equal distances from the centre of the lens, the object and image will be of the same size, and conversely if the object and the image are the same size the distances of the conjugate foci are identical. This, of course, means that object and image are both *beyond* the principal focus; in fact they are at a distance just as much again as is the principal focus, *i.e.* they are on each side twice the distance of the principal focus from the centre of the lens. Therefore, the equivalent focus can be obtained by projecting the image of a brightly illuminated object upon a screen at such a distance that both image and object are equal, and dividing the total distance by four. Having obtained the equivalent focal length, we can easily calculate the magnification with any tube-length.

It is, however, with the magnifying power that the microscopist generally needs to concern himself, and this known, the equivalent focus can be easily obtained. Perhaps the easiest method of obtaining this is that mentioned in Carpenter. A micrometer slide ruled in hundredths and thousandths of an inch, or in tenths and hundredths of a millimetre, is placed upon the stage of the microscope, and the latter inclined to the horizontal position. A strong light is transmitted through the microscope, and the room darkened. The micrometer lines are then focussed sharply upon a piece of white cardboard placed five feet (60 inches) behind the *front* lens of the objective. The divisions on the screen are measured with an ordinary foot or millimetre rule and the result divided by 6, which gives, of course, their size at 10 inches from the objective. The value of the original stage micrometer divisions being known definitely beforehand it is easy to calculate the resulting magnification. Suppose the distance between the micrometer rulings of two 1-1000 of an inch to measure $1\frac{1}{4}$ inches at 5 feet distance with a nominal 1 inch objective. Then at 10 inches distance they would measure ·2083 inch, which is equivalent to an initial magnification of nearly $10\frac{1}{2}$ times. A millimetre scale or rule can be used on the basis of 25·4 millimetres to an inch. Magnifications are always expressed in diameters, or linear measurements, not in areas. A considerable distance such as the above is taken so as to reduce the amount of error due to the fact that the measurements should really be taken from the principal posterior focus of the objective, which in a compound system cannot easily be found. But by measuring from the front lens as above a very small margin of error is left. It is best to take the mean of several micrometer divisions as they are not quite accurately ruled.

Combined magnification of objective and eye-piece is calculated by a similar method except that there is not the same necessity for taking a longer distance, and the image of the micrometer must be accurately projected exactly 10 inches from the eye-lens of the eye-piece. This may be done either direct by means of a photographic camera or otherwise, or at right angles by means of a Beale's camera lucida, to a piece of paper placed on the table, the microscope being raised if necessary to the requisite height so as to get the exact distance of 10 inches *from the eye-lens*. Short-sighted observers may therefore need to use spectacles in order to see the lines on the paper.

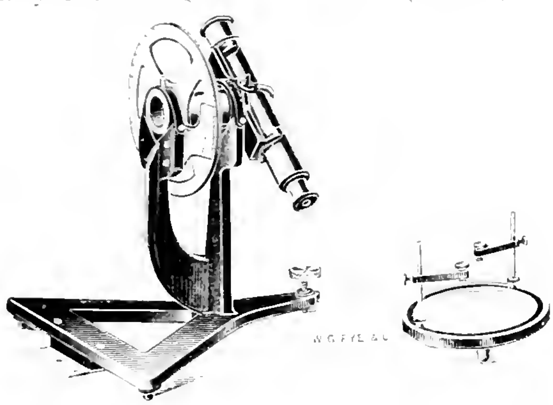
The eye-piece magnification is readily calculated by dividing the combined magnification by the initial magnification of the objective, independently determined. It will be noted that the result, as calculated, gives the magnification with a 10-inch tube; any other length is easily calculated—a 7-inch tube giving an initial magnification of 7-10ths of the result as above obtained, and the eye-piece magnification remaining constant for each eye-piece. One further explanation is perhaps necessary. We have hitherto been dealing with a total magnification calculated for a visual distance of 10 inches from the eye-lens, this being the normal visual distance, but it is as well to bear in mind that in actual practice an abnormal eye will form its image nearer or further away, according to whether the eye be short or long sighted. This will, of course, proportionately affect the magnification of the eye-piece, and, in consequence, the magnification of an

object as seen through the microscope by such an observer.

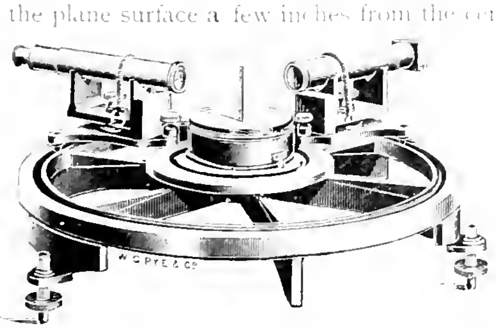
In making calculations connected with focal lengths the most useful formula is $\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$ where p and p' denote the conjugate foci, and f the principal focus. When we know the size of the image and its magnification, and one of the two foci, such as 10 inches, we can use the proportion $D : d :: p' : p$, where D is the diameter of the image, d of the object, and p' the longer of the two foci, then, from the equation given above, *i.e.*, $\frac{1}{p} + \frac{1}{p'} = \frac{1}{f}$, and the ratio $\frac{D}{d} = \frac{p'}{p}$, we obtain $\frac{1}{f} = \frac{1}{p} \cdot \frac{D + d}{d}$, or more simply $f = p \cdot \frac{d}{D + d}$.

New Spectrometer Table.

Messrs. W. G. Pye and Co., of Cambridge, have recently brought to my notice a new combination spectrometer, the adjustments of which present quite new features, and which might, I think, be adapted to certain microscopic accessories. All motions and fittings are arranged geometrically. The base consists of a heavy iron casting on three levelling screws, having



a true lathe-turned surface, with two annular V grooves in it, one near the outer edge, the other a few inches from the centre. The telescope and collimator are provided with tables or carriages consisting of two pieces each, the lower part having two steel balls and one levelling screw for the feet. The balls work in the larger of the two annular grooves mentioned above, and the levelling screw on the plane surface a few inches from the centre.



The upper part consists of a cradle having two V supports in which the telescope or collimator, as the case may be, lies evenly, being held in position by a spiral spring trap. This cradle being clamped by a thumb screw to the lower part provides the necessary adjustment for getting the telescope and collimator into horizontal alignment. The V fittings admit of almost any telescope and collimator being used. The two parts of the carriage are worked up mechanically true, so that very little adjustment is needed to set them optically true after the base has been levelled, which is quickly done by using a spirit level in the usual manner. The carriage for the telescope is provided with a vernier, whilst the one for the collimator has an index pointer only. The prism-plate consists of two parts, the upper of which is capable of adjustment in the horizontal plane without affecting the lower part, which has three spherical ended feet, two resting in the inner V groove, the other working on the plane surface. The simplicity of the arrangement, and the easy way in which it can be worked up mechanically, combined with its steadiness and large bearing surfaces struck me favourably, and as the arrangement could easily be adapted to a reading telescope, to say nothing of adaptations to a model theodolite and sextant, circular vernier, simple dividing engine, &c., I trust its description will not seem out of place here. This instrument, when shown at the Royal Institution on April 3rd last, drew, I understand, considerable attention.

Recent Patents.

19,750. Natural history specimens, preserving. Margosches, F., Liptoujvar, Hungary. Sept. 9.

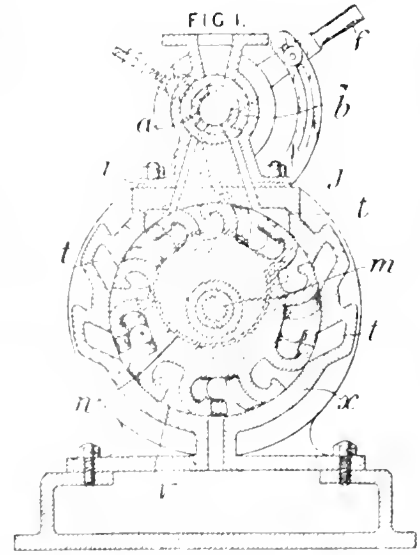
Beetles are preserved in a manner which keeps the joints flexible by treatment with a fluid consisting of specified proportions of alcohol, salicylic acid, sal ammonia, and distilled water, to which arsenic or other substances may be added. The quantity of ammonia to be added depends on the colour of the beetle to be preserved. When thoroughly impregnated, they are placed in a cool closed chamber, to dry, the joints being bent from time to time while the beetles are being dried. The liquid may also be employed in preserving diptera, rhynchota, &c.

19,804. Hydrocyanic acid and cyanides. Wolterbeck, H. C., 3, Edinburgh Mansions, Howick Place, Victoria Street, London. Sept. 10.

A gaseous mixture of, preferably, equal parts of ammonia, a carbon compound, and hydrogen is passed over a suitable catalytic agent, such as platinized pumice, strongly heated and contained in a reaction chamber or series of chambers. The hydrocyanic acid may be collected, or it may be absorbed in caustic potash or soda to produce a cyanide. The carbon compound may be carbonic oxide or acid, or benzene, acetylene, ethyl or methyl alcohol, &c. Water gas may be employed for supplying a mixture of carbonic oxide and hydrogen. The gases or vapours should be free from water. The Provisional Specification states that freshly reduced iron may form the catalytic agent.

19,823. Turbines or impact wheels. MacArthur, C., and Smith, J., both of 75, Church Road, Woolston, near Southampton, Hampshire. Sept. 10.

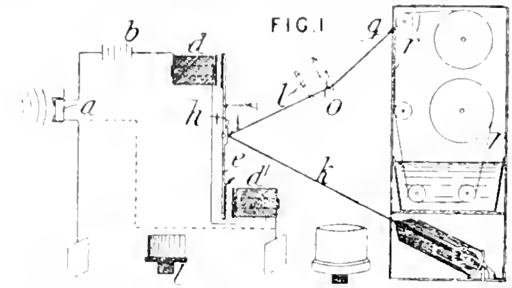
FIG. I.



Relates to impact-wheels driven by expansible fluid pressure, and suitable for propelling ships. The impact-wheel has vanes c sloping in opposite directions alternately and of a corrugated or other curved cross-section. The fluid pressure is admitted twice during each revolution by means of a three-ported tubular valve a, which is rocked by an eccentric n on the main shaft n. The admission valve is surrounded by a ported sleeve o, which forms a reversing valve, and which can be rocked by a handle f to admit the fluid to the port t for forward running or to the port for backward running. Expansion chambers t are formed in the wall of the cylinder a.

19,901. Electric recording apparatus. HULSMEYER, C., 98, Bilker Allee, Dusseldorf, Germany. Sept 11.

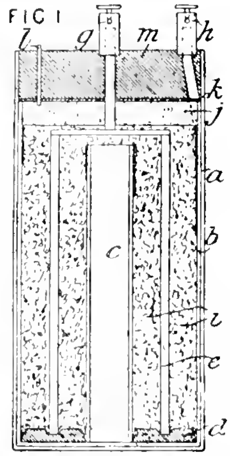
FIG. I



Relates to apparatus for recording the variations of an electric current in the form of a photographic record produced by the variations in a beam of light The particular example shown consists in imposing sound waves on a microphone *a* in an electric circuit including a constant battery *b* and magnet coils *d*, *d*¹. The armatures of the magnets are mounted on a spring-controlled pivoted mirror *e* carrying at its centre a mirror *h*. A beam of light *k* is reflected from the mirror on to a travelling photographic film *f* enclosed in a case having developing and fixing apparatus; *g* is a small opening in the case. The beam of light is varied by passing through an optical plate *l* of varying transparency from end to end, and is focussed on to the opening *g* by one or more prisms or cylindrical lenses *o*. The light-varying portions of the apparatus are adjustably mounted to allow of varying the sensitiveness. The record may be used for reproduction by causing it to vary an otherwise constant beam of light falling on a selenium cell in an electric reproducing circuit.

19,999. Secondary batteries. FIEDLER, L., 71, Huntley Street, Tottenham Court Road, and PUCHMULLER, G., 14, Mornington Crescent, both in London. Sept. 12

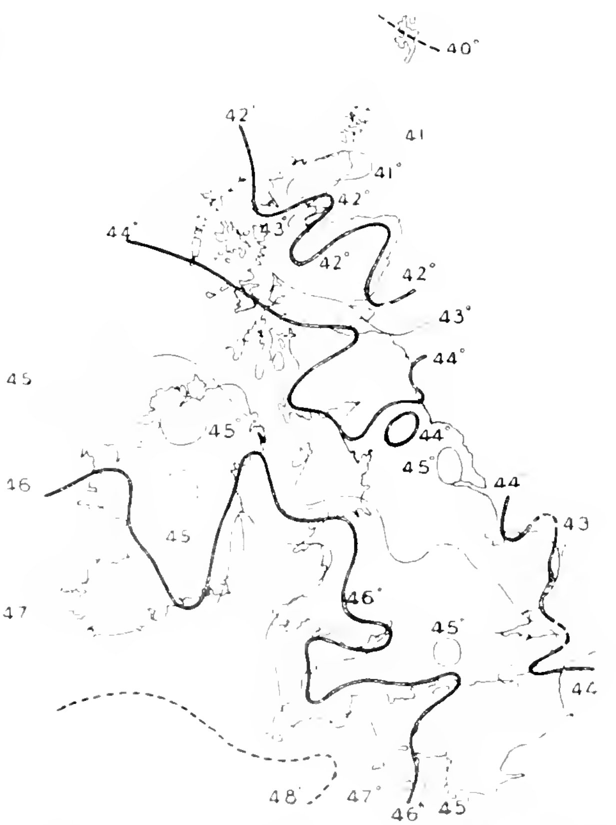
FIG I



Relates to the use of zinc as the negative plate. The battery consists of a papier-mâché box *a* containing a tightly-fitting zinc box *b*, which is connected with a second zinc box *c*, the two forming one electrode *h*. Upon the insulating-material, such as asphalt, which covers the bottom of the box *b*, the lead-peroxide anode *e* stands, and forms the other electrode *g*. The electrolyte *i* consists of a mixture of sulphuric acid, mercury sulphate, potassium ferro-cyanide, and zinc sulphate, and this forms a covering of zinc-mercury ferro-cyanide upon the zinc electrode, and protects it from the sulphuric acid when the accumulator is not in use. The electrolyte may be either liquid or rendered "dry" by an absorbent such as sawdust The cell is closed in with a layer of sawdust *j*, a piece of cardboard *k* soaked in paraffin, and a layer of mastic material *m*, through which is an air pipe *l*.

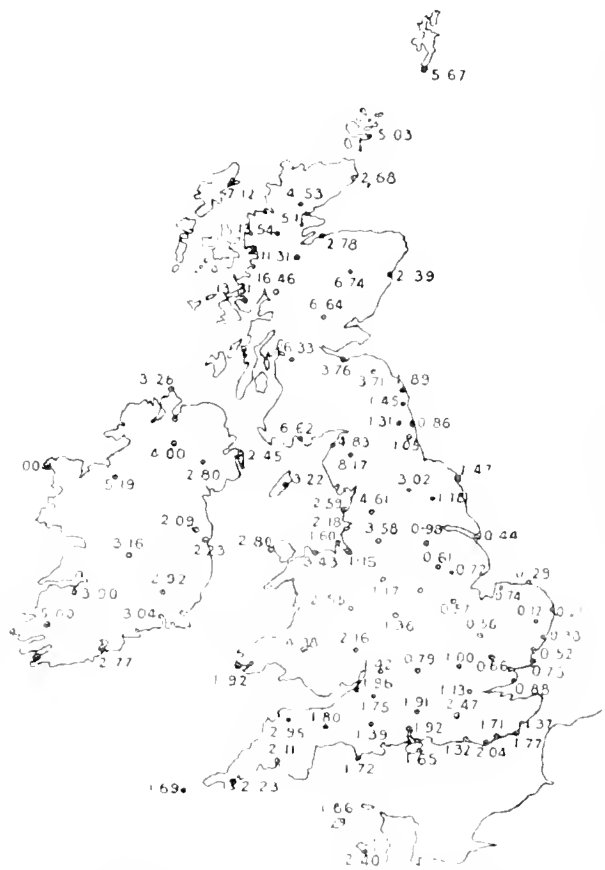
LAST YEAR'S WEATHER—FEBRUARY, 1903.

DISTRIBUTION OF MEAN TEMPERATURE.



Over the country generally the temperature was considerably above the average, the excess amounting to more than 4° in all districts, excepting the north of Scotland and the south of Ireland, to more than 5° in many parts of northern, eastern, and central England, and to as many as 6°·2 at York.

RAINFALL.



Rainfall was very deficient in the eastern, central, and southern parts of England, and also at some stations in the south of Ireland. In the western and northern districts generally there was a considerable excess, the amount at many of the Scotch stations being more than twice as much as the average.

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Contents and Notices. See Page VII.

The Ancestry of the Camel.

By R. LYDEKKER.

CAMELS—or rather some of their immediate ancestors—have been accorded a privilege commonly said to be reserved among ourselves for the fair sex; in other words, metaphorically speaking, they have been permitted to change their minds. For there can be little doubt that when these animals originally started on the road of getting up in the world—that is to say, on a course of specialised development—they intended to become good and typical ungulates like their distant cousins the true ruminants; and, for a time at least, the ancestral camels appear to have had their toes encased in good serviceable hoofs of horn. For some reason or other, of which we are at present quite ignorant, they appear to have considered that this plan was a mistake, and they accordingly struck out a line of their own, and underwent a kind of retrograde evolution, with the result that in their modern descendants their feet, instead of being covered with hoofs, are fitted with large spreading and elastic cushions, in which the two toes are to a great extent buried, bearing small nails on their upper surface only. The reason for this remarkable modification is not very easy to see. It is true, indeed, that the cushion-like feet of the typical camels of the Old World (from which the group derives its scientific title of *Tylopoda*) are admirably adapted for walking on the yielding sands of the deserts of Central Asia and Africa. But, on the other hand, such deserts are likewise the home of many hoofed ruminants, such as the North African addax antelope and the Mongolian gazella. Again, the wild representatives of the South American llamas (which, in a collective sense, also come under the denomination of camels) are associated in their native wilds with the guemal deer, which, like the rest of its kind, has horny hoofs of the normal type. Moreover, the wild Mongolian ponies inhabit the same tracts as the half-wild camels of the same country.

All that can be said, therefore, is that we must take facts as we find them; and that, for some reason with which we are unacquainted, the members of the camel tribe have developed a type of foot quite unlike that of any other ungulates, and well adapted, although by no means essential, to the countries where these animals are found. Away from such tracts, the feet of camels are, however, not infrequently a source of inconvenience, or it may be absolute helplessness, to their owners. For instance, on the smooth "kankar" roads of the Punjab, which in wet weather become sticky and slippery, camels are utterly unable to progress, their washleather-like padded feet sliding from under them, and rendering them as helpless as a cat on ice.

Although, in a literal sense—that is to say, from the fact that they "chew the cud"—the members of the camel tribe are ruminants, yet they are structurally very different from the true ruminants—the Pecora of zoologists—and are consequently referred to a separate group of equal value, for which the aforesaid name of *Tylopoda* is now in general use.

In addition to their cushion-like feet, camels (including now and hereafter all the existing members of the group and their immediate ancestors under this title) are broadly distinguished from the true ruminants by the following features:

In the first place, instead of having the front of the upper jaw entirely toothless, the full series of three pairs of incisor teeth are present in the young, while in the adult the outermost of these pairs are an isolated curved and pointed tooth, and there is also a well-developed pair of canines, or tusks. Again, the lower canines, in place of being approximated to the incisors and resembling them in shape, retain the more usual isolated position and sharply-pointed form. As regards the cheek-teeth, although the majority of these are of the crescentic type characteristic of all ruminating mammals, yet there are certain peculiarities in form whereby they are readily distinguished from those of the true ruminants; and, what is more important still, one or more at the front of the series are usually detached from those behind, and assume a sharply-pointed form.

In the skeleton the thigh-bone, or femur, is placed much more vertically, by which means the thigh is much more distinct from the flank, while the knee-joint is placed lower down than in the true ruminants. Another peculiarity is to be found in the unusual length and pointed form of the knee-cap, or patella. Then, again, none of the bones of the wrist and ankle-joints (carpus and tarsus) are welded together. As regards the lower part of the limbs, although the upper segments of the two remaining toes (the third and fourth of the typical series of five) are welded together to form a cannon-bone (fig. 1); yet they diverge to a much greater extent at their lower extremities than is the case with the true ruminants. Moreover, in place of each of the two lower articular surfaces of the cannon-bone having a projecting ridge to fit into a groove in the upper surface of the uppermost toe-bone, such surfaces are perfectly plain and smooth (fig. 1). Probably, owing to the nature of the foot itself, there is less liability to dislocation than in the hoofed feet of the true ruminants, and a "tongued joint" is therefore unnecessary. As regards the toe-bones themselves, it will suffice to say that the third or terminal pair form small irregular nodules, quite unlike the symmetrically flattened form characterising those of the true ruminants.

Perhaps, however, the most important peculiarity in the skeleton of the camels (and it will be unnecessary on this occasion to refer to the soft-parts) is to be found in the vertebræ of the neck, which are unusually elongated. In all other mammals, with the exception of the extinct South American macrauchenia, the canal for one of the great arteries for the neck perforates the process projecting from each side of the vertebræ: but in the camels and macrauchenia it runs obliquely through the side-wall of the tube for the spinal marrow.

Fig. 1.—Front Cannon-Bone of a Camel.

All these features combined serve to show that the camel tribe is widely separated from the true ruminants. How far back we have to go before we come to the common ancestral stock is indeed at present uncertain. Possibly both groups are independently derived from primitive ungulates in which the cheek-teeth had not yet developed a crescentic type of structure. Be this as it may, it is quite certain that the ancestral camels had low-crowned cheek-teeth, comparable to those of the ancestral horses.

Indeed, making due allowance for the fact that in the one case the modification has been carried on the artiodactyle, and in the other on the perissodactyle plan (that is to say, with the enlargement of the third and fourth toes, instead of the third alone), the evolution of the camels has followed much the same lines as that of the horses. And this is only what might have been expected, since, as stated in the previous article of this series, it is only on such lines that we can conceive evolution of this nature to be possible.

As examples of this general similarity, or parallelism, I may refer, in the first place, to the enormous increase in bodily size which has taken place. Equally noticeable is the elongation of the bones of the lower segments of the limbs, coupled with the tendency to do away with double bones in such of those segments as they exist, the suppression of the lateral digits, and the enlargement of those which remain. In both cases there is likewise a progression from low-crowned to tall-crowned cheek-teeth, and in both the development of a bar of bone beyond the eye so as to enclose its socket in a complete bony ring.

The combination of all these factors tends (in addition to the augmentation of bodily size) to increase the speed and the longevity of the animals, and at the same time to render them fitted to subsist on the vegetation characteristic of the present and immediately preceding epochs; the strengthening of the limbs so as to enable them to support the increased weight, and at the same time to withstand the strain of the increased speed, being, of course, an essential feature of the process.

Apart from certain still older and more primitive mammals, with teeth of the tubercular type, the earliest known form which can definitely be included in the camel series is *Protylopus*, of the Uinta, or Upper Eocene period of North America. In this creature, which was not larger than a European hare, there was the full typical number of 44 teeth, which formed a regular series, without any long gaps, and with the canines but little taller than the incisors, while the hinder cheek-teeth, although of the crescentic type, were quite low-crowned. In both jaws the anterior front teeth were of a cutting and compressed type. Unfortunately, the skull is incomplete, and the rest of the skeleton very imperfectly known; but sufficient of the former remains to show that the socket of the eye was open behind, and of the latter to indicate that in the hind foot, at any rate, the upper bones of the two functional toes had not coalesced into a cannon-bone. The lateral hind toes (that is to say, the 2nd and 5th of the typical series) had, however, already become rudimentary; although it is thought probable that the corresponding digits of the fore-limb were functional, so that this foot was four-toed. Very remarkable is the fact that in old individuals the bones of the fore-arm (radius and ulna) became welded together about half-way down, although they remained free above. On the other hand, it appears that the smaller bone of the leg (fibula) was welded to the larger one (tibia), and that its upper portion had disappeared. Nothing is known of the neck-vertebræ. It is, of course, evident that there must have been an earlier form in which all the feet were four-toed, and the bones of the fore-arm and lower part of the leg separate.

A stage higher in the series, namely, in the Oligocene, we meet with the much better known *Poebrotherium*, the skull of which (fig. 2) was described so long ago as 1847. In this animal, which is also American, a distinct increase

Fig. 2.—Skull of Poebrotherium

in bodily size is noticeable, as is also one in the relative length of the two bones which unite in the higher types to form the cannon-bone. Moreover, the crowns of the hinder cheek-teeth are rather taller and more distinctly crescentic, both feet are two-toed, the ulna and radius were fused, and the fibula was represented only by its lower part. In the vertebræ of the neck the distinctive

cameloid characters had already made their appearance. On the other hand, the skull (fig. 2) was short and rabbit-like, showing none of the characteristic features of those of the modern camels.

Reaching the period of the Lower Miocene, we come to a genus, *Gomphotherium*, in which there is a considerable increase in the matter of bodily size, the two metapodial bones (or those which unite in the later forms to constitute the cannon-bone) being fully double the length of the corresponding elements in *Protylopus*. Moreover, these bones, although still separate, have their adjacent surfaces much more closely applied than is the case in the latter. Again, in this and the earlier genera the terminal toe-bones indicate that the foot was of the normal hoofed type. On the other hand, in the skull (fig. 2) the socket of the eye is completely surrounded by bone: while the dentition begins to approximate to the camel type—notably by the circumstance that the lower canine is either separated by a gap from the outermost incisor, or that its crown assumes a backwardly curved shape. Brief mention must suffice for *Protolabis* of the Middle Miocene, in which, while no cannon-bone is formed, the first and second pairs of incisor teeth are retained, and the limbs and feet are short and disproportionately small.

In the Upper Miocene, on the other hand, we come to a very distinct type—*Procamelas* which is clearly entitled to be regarded as a camel, and approximates in size to a small llama. Here the metapodials have at least partially united to form a cannon-bone; the skull has assumed the elongated form characteristic of modern camels, with the loss of the first and second pairs of

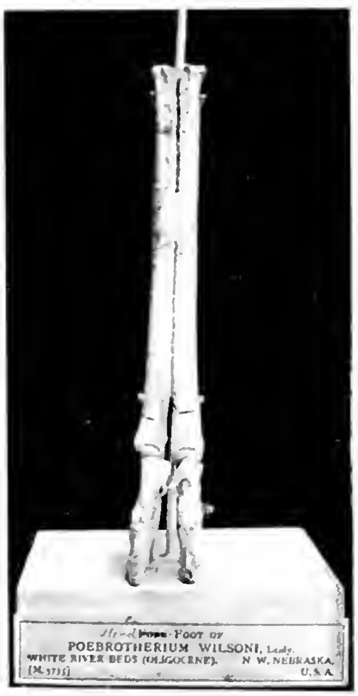


Fig. 3.—The Bones of the Hind-Foot of Poebrotherium, showing the distinct metatarsals, which coalesce in the higher forms into the cannon-bone.

upper incisors, and the development of gaps in front of and behind each of the next three teeth, that is to say, the third incisor, the canine, and the first cheek-tooth. The approximately contemporaneous *Pliauchenia* makes another step by the loss of the second lower cheek-tooth. Both these genera have the toe-bones of the irregular nodular form distinctive of the modern camels, so that we may safely infer that the feet themselves had assumed the cushion type.

In one species of *Procamelus* the metapodial bones coalesced into a cannon-bone late in life; but when we come to the Pleistocene *Camelops* such union took place at an early stage of existence, and was thoroughly complete. In the living members of the group it occurs

Fig. 4.—Hind Cannon-bone of a modern Llama to contrast with the foot of "Poebrotherium," and to show the type characteristic of "Procamelas" and higher forms.

even before birth. The species of *Camelops* were probably fully as large as llamas (including guanaco and vicuna), and some of them, at any rate, resembled these animals as regards the number of teeth, the incisors being reduced to one upper and three lower pairs, and the cheek-teeth to four or five in the upper and four in the lower jaw; the total number of teeth thus being 28 or 30 in place of the 44 of *Poebrotherium*. The sole difference between *Camelops* and *Llama* seems to consist in certain structural details of the lower cheek-teeth. An allied extinct genus (*Eschatius*) is also distinguished by certain features in the dentition.

All the foregoing genera are exclusively North American. A lower jaw from the Pleistocene deposits of that Continent has, however, been referred to the true camels (*Camelus*), which differ from the llamas, among other features, by their greater bodily size, well developed hump, or humps, the presence of five pairs of lower cheek-teeth, and the complete bony ring round the socket of the eye.

Outside America, remains of true camels are met with in the Lower Pliocene Siwalik strata of India, as well as in the Pleistocene of South-Eastern Europe and Algeria; and it is noteworthy that the cheek-teeth of the Siwalik camel (*Camelus sivalensis*) display a structural feature now exhibited by those of the llamas. From Pleistocene or Pliocene in China have been obtained remains of a large camel-like animal named *Paracamelus*, which also shows certain signs of affinity with the llamas in respect of its cheek-teeth.

The above survey, brief as it is, suffices to show that the huge camels of the present day have been gradually evolved from creatures not bigger than a hare, on lines closely paralleled in the case of the horse. In one

respect the camels have indeed beaten the horse, having entirely got rid of the splint-bones representing the outermost pair of the original four toes. Further, in having exchanged the hoofed for the cushioned type of foot, they have undergone a kind of retrograde development, for which there is no parallel in the horse line.

Fig. 5.—Skull of Modern Camel, showing the reduced number of upper incisor teeth, and the ring of bone round the eye-socket.

Here a brief diversion must be made to notice an extraordinary North American Miocene form, which is off the main line. This is the giraffe-necked camel (*Alticamelus*), a creature of the size of a giraffe, with similarly elongated neck and limbs, and evidently adapted for browsing on trees. The feet and number of teeth were generally similar to those of *Procamelus*. Unlike the giraffe, the length of the limbs is due to the elongation of the bones of the upper segments (femur and tibia) and not the cannon-bones; while the fore-limbs are not higher than the hind ones. The length of neck is due to the elongation of the anterior neck-vertebræ; if the hinder ones had been lengthened, the height of the body would have been increased without any compensating advantage. This creature affords one of the most extraordinary instances of special adaptation known to science.

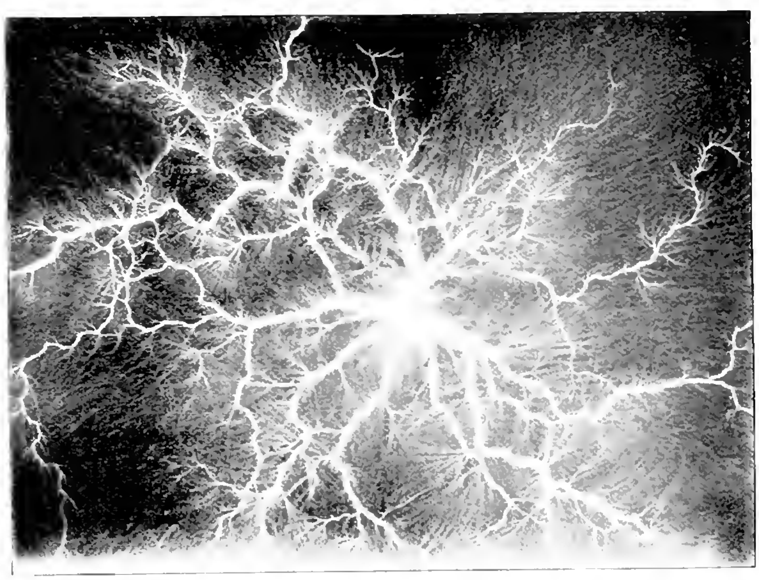
The remaining space at my disposal must be devoted to certain considerations concerning the birthplace and geographical distribution of the group. It is claimed by Transatlantic palæontologists that North America was the original home of the *Camelidæ*, and so far as the earlier members of the group are concerned, there is nothing at present to justify a contradiction of this. The case is, however, very different with the latter forms. We have seen that in North America the formation of a complete cannon-bone did not take place till the Pleistocene, at which epoch true camels also made their first appearance. But such camels, with complete cannon-bones, were in existence in India in the early Pliocene. Obviously, therefore, the evolution of these animals must have taken place somewhere in Asia; this view being supported by the occurrence there of the aforesaid *Paracamelus*. Hence it is quite probable that some of the earlier stages of the evolution of the group may have been carried out in Asia, when that continent was united by way of Behring Strait with North America. The Siwalik camel, it may be added, may have given rise to the existing two-humped Bactrian species; while from the extinct Russian and Roumanian camels the single humped Arabian species may have sprung.

With regard to the llamas of South America, palæontology goes to prove that the ancestral forms first obtained entry into that contintent from the north during the Pliocene period, when free communication was established between North and South America. Now all these ancestral forms, of which there are several distinct generic types, appear to have complete cannon-bones. Consequently, unless we are prepared to admit that these compound bones have been independently evolved in the camels and the llamas, the latter cannot have been derived from the known North American Pliocene forms, in which the union of the constituent elements of these compound bones was incomplete. Consequently, it seems a probable supposition—and this is supported by the above-mentioned structural resemblance between the cheek-teeth of the Siwalik camel and those of the llamas—that the latter animals, like the true camels, were evolved in Eastern Central Asia, whence they reached South America by way of the Pacific border of the northern half of the New World, possibly over land long since submerged.

The Photography of Electric Sparks.

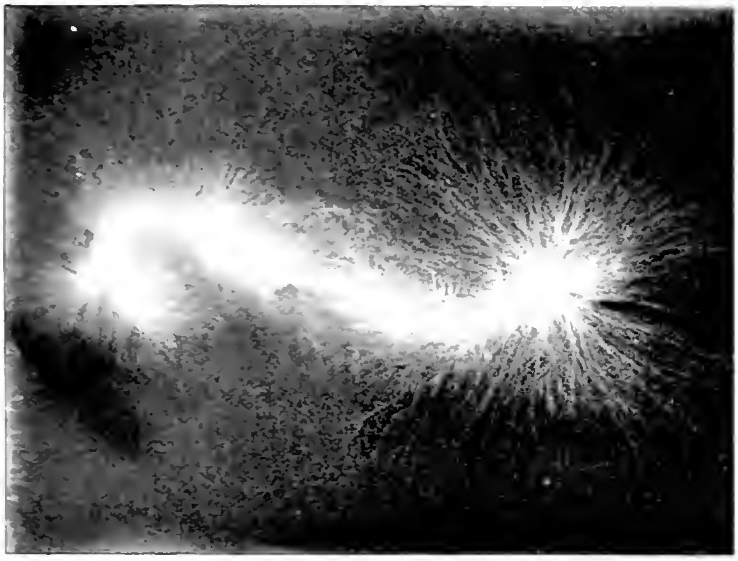
The Photography of Some Electrical Phenomena was the subject of a lecture delivered on January 25, 1904, at the Camera Club, Charing Cross Road, by Dr. George H. Rodman.

The lecturer commenced by describing the method that he had adopted in obtaining the photographic representation of electric sparks from a 10-inch induction coil actuated by accumulators. It seemed to matter but little what voltage was used in the primary circuit, and the results shown were produced at a voltage varying from 6 to 24 in the primary.



Single Positive Discharge.

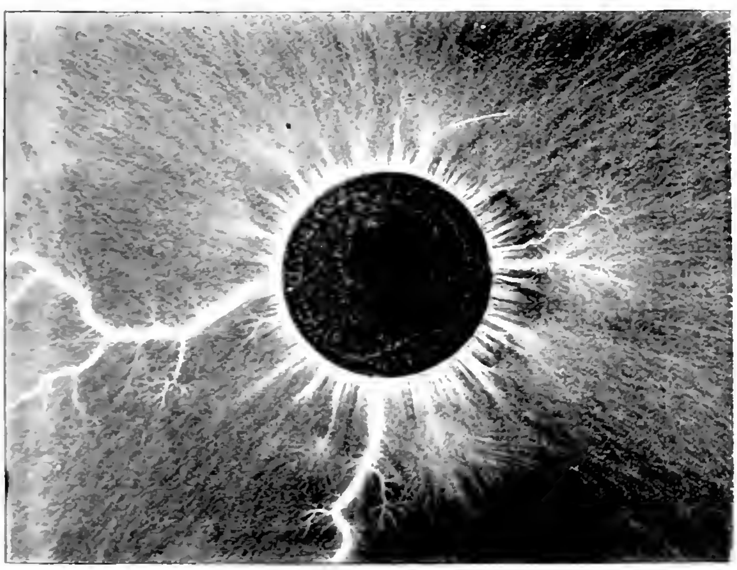
Single and multiple discharges were discussed; the former occupying a very short space of time, possibly about $\frac{1}{20,000}$ of a second. Numerous representations of sparks taken under different conditions were shown, and



Single Discharge between Points.

attention was called to the marked difference between the positive and negative discharge, the former having a brush-like appearance, and the latter invariably showed a characteristic fern-like representation on the plate.

The lecturer showed excellent examples of the increased intensity of the spark when a spark gap was introduced into the secondary circuit, and in passing remarked that this was the explanation of the use of a spark gap employed in connection with the sparking plug of motor vehicles.



Single Positive Discharge on Florin.

Examples of sparks from brushes and spheres, in addition to ordinary point discharges, revealed many extraordinary effects; and in all the characteristic features of the positive and negative discharge were invariably present. The results, Dr. Rodman explained, were obtained on Imperial plates, which were subsequently developed in the usual manner with a pyro-soda solution.

The production of the photographic image of coins placed on the surface of the emulsion, and connected up with one or other terminals of the coil furnished some highly interesting results; and in these cases the characteristic features of the positive and negative discharges were well shown.

On passing a single discharge on these coins with subsequent development of the latent image, a very distinct representation of the coin with its inscription clearly legible was produced, and the same effect was obtained in a much

Single Negative Discharge on Coin.

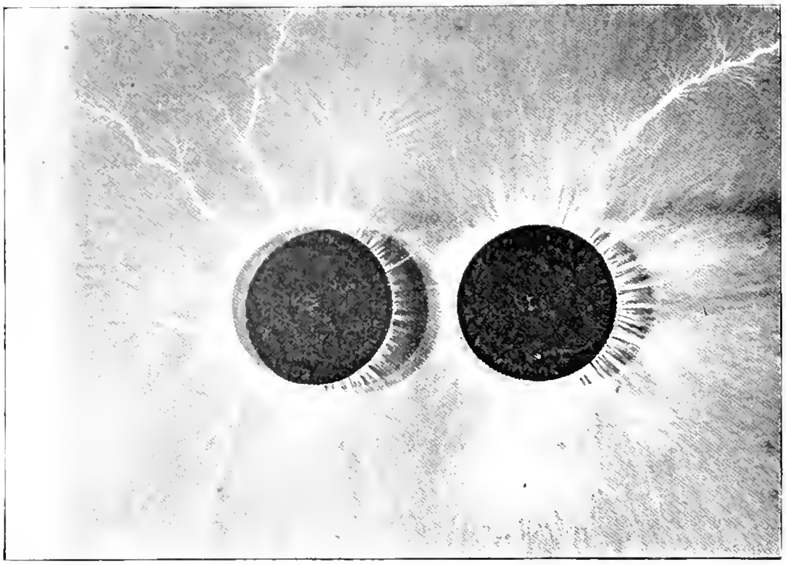
clearer manner when a multiple discharge of current extending to 1-20th sec. was used.

In this experiment when a discharge was produced with two coins attention was called to the remarkable appearance that the plate on development presented the image of both coins being multiple. Dr. Rodman stated that he had up to the present been unable to determine the cause of these multiple images, and, in order to arrive at a conclusion as to the cause of these nimbus-like shadows, had adopted various devices, but had failed with them to elucidate the matter.

Assuming that they were the result of reflection, films had been used instead of the glass plates employed in the other experiments. Backed plates had also been made use of, but the multiple shadows still presented themselves. To exclude the possibility of their being pro-

duced by reflection from the edges of the coins, these had been painted with non-actinic colour.

Finally, it was thought that the coins might have been thrown into a state of agitation, and had moved during the passage of the current, and to exclude this possibility



Single Positive Discharge on two Coins. Both Coins in Spherical Connection.

they had been enclosed and supported in a couple of circular holes made to fit the coins in a card at the time of exposure. This peculiar feature of the experiment was met with when coins of unequal size and of varying metals were employed, and was also noticed when the glass insulating plate was replaced by an india-rubber pad.

Modern Cosmogonies.

VII.—Cosmogony in the Twentieth Century.

By Miss Agnes Clerke, F.R.A.S.

Prospective and retrospective inquiries into physical conditions stand very much on the same footing. The same degree of uncertainty attaches to results of both kinds; the same qualifications need to be applied to them; a similar reserve is understood to accompany our admission of them. The reserve grows more marked as science unfolds to our surprised apprehension the multiplex possibilities of Nature. The time has gone by when "men of light and leading" could draw cheques for unlimited amounts on the bank of public credulity. Not that the balance has diminished, but that it is otherwise employed. Most of us, in these days, have learnt to "look before and after" for ourselves; and we instinctively mix the proverbial grain of salt with what is told to us, even on the highest authority. Ideas are on the move; dim vistas are opening out; much that lies beyond the verge of actual experience is seen to be possible, and sedate reasoning may at any moment suffer outrage by fantastic discovery. Hence, dogmatism is at a discount.

The secular parallax affecting men's views of the universe is nowhere more strongly apparent than in the trend taken by speculations as to its origin. They have become more subtle, more far-reaching, yet less confident. They have ramified in unexpected directions, but rather tentatively than with the full assurance of attaining absolute truth. Laplace considered only the solar system, from which he arbitrarily excluded comets; on the vast sidereal world he bestowed barely casual attention. Sir William Herschel, on the other hand, occupied himself exclusively with the growth-processes of nebulæ, relegating the details of planetary evolution to a position of secondary importance. Later, the spectroscope having become available for discriminating generic differences among the suns in space, their relative ages, the order of their succession, their mutual affinities, claimed predominant attention. Just now, however, the flood of ideas is too high to be restrained within separate channels; cosmogonists look far afield; they aim at obtaining a general survey of relations baffling in their complexity. To some extent they have succeeded; parts are beginning to find their places in a great whole; links are seen to connect phenomena at first sight seemingly isolated; on all sides, analogies are springing into view. The unwearied circling of the moon, and its imperturbable face, remind us how a sun may have been born; the flash of every meteor suggests the mode by which suns die. The filmy traceries of comets intimate the nature of the force acting in nebulæ; the great cosmic law of spirality is distantly hinted at by the antipodal disturbances of the sun. Thus, one set of facts dovetails into the next; none can be properly considered apart from the rest.

The limitations of the human mind, nevertheless, require a subdivision of labour. Individual efforts cannot grapple with the whole of the known and the knowable; and the larger part of both is included in the scope of modern cosmogony. It deals with all that the skies hold, visibly or invisibly; draws unstintingly on time past and time to come; concerns itself equally with gradual transformations and sudden catastrophes, with the dissipation and concentration of energy, with the subtle interplay of matter and force, with physical and ultra-physical, chemical and electrical modes of action. But let us consider a little more particularly how things actually stand, so as to collect some definite ideas regarding the lines of advance practicable and promising for the immediate future.

To begin with our domestic circle. The insecure state to which Laplace's scheme has been reduced by the assaults of numerous objectors has found compensation in the development of tidal theory. Much light has thereby been thrown upon planetary pre-history. The relations of planets to the sun, and of satellites to planets, have been rendered comparatively intelligible. Noticeable above all is the discovery thence ensuing of the earth's critical situation, just outside the boundary of the region where planetary rotation was destroyed by sun-raised tides, and with it the prospects of planetary vitality. Moreover, the consequent dubious state of the inchoate terrestrial spheroid accounts for the peculiar mode of birth of the moon, and the distinctively binary character of the earth-moon system; while the variety perceptible in the circumstances of the different planets precludes the employment of any single recipe for their

development from a primal vortex. The forces concerned, we can now see, acted in a far more complex manner than could formerly have been supposed: and their balance was proportionately more delicate. To which side it would have inclined in a given case must then often be incalculable, or calculable only with the guidance of the known result. The strict bonds of reasoning have thus become somewhat relaxed, and difficulties that looked formidable have, in the long run, proved not to be insuperable. But conviction has also grown faint. The old, imposing façade of theory remains erect: the building behind it has been for the most part pulled to pieces, and the architect has yet to be found who can reconstruct it to our satisfaction.

On one point we have, nevertheless, acquired certainty. It is now known that comets with their dependent trains of meteors are aboriginal in the solar system. They are no unlicensed intruders, but collateral relations of the planetary family. Possibly, they represent waste scraps of world-stuff which escaped the action of the formative machinery; and if so, they exemplify its primitive texture. Not that their composition need be, on this supposition, identical with that of the planets. A sifting of elements would have been likely to accompany the processes of cooling and contraction. Comets were perhaps made (so to speak) of the white of the nebulous egg, planets of its yolk. But in any case, we may safely regard the glimmering fabrics of acetylene and cyanogen that occasionally illuminate our skies as shearings from a wide-spreading, fleecy haze, flung aside before "the starry tides" had as yet begun to "set towards the centre." In one respect, the quality of these relics is a surprise. They show no chemical affinity with nebulæ. Their spectra are radically different from nebular spectra, gaseous or continuous. They accordingly lend no countenance, although not fatally adverse to the view that the sun was once, in the distinctive sense, a nebulous star.

The grand topic of sidereal succession is no longer abandoned to fruitless surmises. Broad lines have been laid down, along which—so far as we can at present see—progress must inevitably have been conducted. And one fact of overwhelming significance in this connection is entirely of recent discovery. The multitudinous existence of obscure bodies in space had, indeed, been foreseen as a logical necessity long before Bessel founded the "Astronomy of the Invisible"; but it has been substantiated almost wholly by modern spectrographic methods. Decrepit or dusky suns are assuredly no imaginary product, but a potent reality: though it would be too much to assert that all have sunk to extinction by the same road.

We stand, too, on firmer ground than our predecessors in respect to the history of stellar systems. That its course is mainly prescribed by the influence of tidal friction has been ably demonstrated by Dr. See. Telescopic double stars can be led back, by the aid of this clue, to an initial stage, when they revolved close together, very much like the earth and moon in Professor Darwin's theory: and it was owing to their voluminousness, and the unequal attractions it engendered, that their orbits became enlarged and elongated to the degree generally observed. Spectroscopic binaries, moreover, illustrate earlier modes of circulation; they present us with couples fully separated, and still separating, as well as with others barely divided, and revolving almost in contact. Nay, they include specimens, we are led to believe, of globes conjoined into the apioidal figure theoretically investigated by Darwin and Poincaré, which may be regarded as preparatory to the development, by fission, of two mutually revolving stars from one primitive rotating mass. One of these supposed dumb-bell systems is the variable V Puppis; and if the eclipse-rationale of its obscurations be confirmed by the spectroscope, there is no gainsaying the inference that it is composed of two stars actually contiguous, if not commingled.

Now compound stars are by no means of exceptional occurrence. Their relative abundance has been found to augment rapidly with every advance in our knowledge of the heavens. From the measures of stellar radial velocity lately carried on at the Yerkes Observatory by Professors Frost and Adams, it appears that the proportion of binary to single stars considerably exceeds Professor Campbell's earlier estimate. Of those giving helium-spectra, at any rate, there are most probably as many of one kind as of the other. But why the distinction, it may be asked: and the answer is not far to seek. Helium-stars are the most primitive, and form the closest, and most readily apparent systems. A physically double star must always remain such. There is no law of divorce by which it can put away its companion, although their relations must alter with time. But their alteration tends continually to enhance the difficulty of their detection. For as the members of a pair are pushed asunder by tidal friction, their velocity slackens, and the tell-tale swing of their spectral lines diminishes in amplitude, and finally, by its minuteness, evades observation. And since the majority of spectroscopic satellite-stars are very imperfectly luminous, their eventual telescopic discovery, when far enough away from their primaries to be optically separable from them, would rarely ensue. It must then be concluded that half the stars in the heavens (let us say) broke up into two or more bodies as they condensed. What follows? Well this. Half the stars in the heavens were, from the first, incapacitated from becoming the centres of planetary systems. To our apprehension, at least, it appears obvious that a binary condition must have inhibited the operations of planetary growth. These innumerable systems are doubtless organised on a totally different principle from that regulating the family of the sun. The Nebular Hypothesis, even in its most improved form, has no application to them; the Meteoritic Hypothesis still less. Mathematical theories of fluid equilibrium, combined with a long series of changes due to tidal friction, afford some degree of insight into the mode of their origin and the course of their development. Yet the analogy with the earth-moon couple, which irresistibly suggests itself, is imperfect, and may be misleading, owing to the wide difference in state between plastic globes approaching solidification and sun-like bodies, radiating intensely and probably gaseous to the core.

The world of nebulæ presents us with complete cycles of evolutionary problems, which can no longer be treated in the offhand manner perforce adopted by Herschel. The objects in question are of bewildering variety; yet we can trace, amid their fantastic irregularities, the underlying uniformity of one constructive thought. Nearly all show, more or less markedly, a spiral conformation: and a spiral conformation intimates the action of known, or discoverable laws. Their investigation must indeed be slow and toilsome; its progress may long be impeded by the interposition of novel questions, both in physics and mechanics; nevertheless, the lines prescribed for it seem definite enough to give hope of its leading finally to a clear issue. And when at last something has been fairly well ascertained regarding the past and future of nebulous spirals, no contemptible inroad will have been made on the stupendous enigma of sidereal relationships.

Its aspect, if we venture to look at it in its entirety, is vast and formidable. Not now, as in former times, with a mere fragment of creation—a single star and its puny client-globes, one of which happens to be the temporary abode of the human race—but with the undivided, abysmal cosmos, the science of origin and destiny concerns itself. The obscure and immeasurable uncertainties of galactic history invite, or compel attention. We know just enough to whet our desire to know a great deal more. The distribution of stars and nebulæ is easily seen to be the outcome of design. By what means, we cannot but ask ourselves, was the design executed? How were things ordered when those means began to be employed? How will they be ordered when all is done? For an ultimate condition has, presumably, not yet been reached. And if not, agencies must be at work for the perfecting of the supreme purpose, which are not, perhaps, too subtle for our apprehension. Meanwhile, facts bearing on sidereal construction are being diligently collected and sifted: and we shall do well to suspend speculation until their larger import is made known.

The inquisitions of science do not cease here. They strive to penetrate a deeper mystery than that of the scattering in space of stars and nebulæ. What are they made of is the further question that presents itself. What is the nature of the primal world-stuff? Whence did it obtain heat? By what means was motion imparted to it? If it be urged that such-like topics elude the grasp of finite intelligence, and belong to the secrets of Creative Power, we may reply that we are not entitled, nor are we able to draw an arbitrary line, and impose a *ne plus ultra* on our thoughts. The world has been, by express decree, thrown wide to their excursions, and it is not for us to restrict their freedom. We need not fear getting too near the heart of the mystery; there is no terminus in the Unknown to which we can travel by express: in a sense, we are always starting, and never get nearer to our destination. But that is because it retreats before us. We do, in truth, advance: and as we advance, the mists clear, and we see glimpses beyond of imperishable order, of impenetrable splendour. Our enquiries need not then be abandoned in despair at the far-reaching character they have spontaneously assumed.

From the earliest times there has been a tendency to regard varieties of matter as derivative. They have been supposed to be procured, by supra-mundane agency, or by the operation of inherent law, from some universal, undifferentiated substance. We moderns call that substance "Protyle,"* and believe ourselves to be in experimental touch with it. The implications of this view we shall consider in the next chapter.

* A term signifying "first matter," constructed from corresponding Greek words by Roger Bacon, and revived by Sir William Crookes.

The Conductivity of Selenium.

Mr. E. A. Hopius, in an investigation recently presented to the Russian Physico-Chemical Society, has made a series of experiments with an apparatus constructed by Mr. M. Kohl and another apparatus designed by himself on selenium supplied by the firm of E. Merk, Darmstadt, the former apparatus being illuminated by a standard amyl acetate burner at distances ranging from 10-200 cm., and the other by a Nernst lamp placed at the same distance. The measured current intensity agreed fairly well with the hypothesis of a direct proportionality between the increase in the conductivity of selenium and the cubic root of the intensity of illumination.

Borings on a Coral Island.

The Atoll of Funafuti.

NEARLY a quarter of a century ago Charles Darwin penned the following words in a letter to Prof. Alexander Agassiz: "I wish that some doubly rich millionaire would take it into his head to have borings made in some of the Pacific and Indian atolls, and bring home cores for slicing from a depth of 500 or 600 feet." The profound interest which Darwin had himself long previously aroused by his theories regarding the structure of coral reefs and their mode of origin could not do otherwise than henceforth make the subject an integral part of geological science, and one, too, of striking significance. It was, therefore, to be expected that the hopeful words of the master-naturalist would ripen with time to bear fruit in effort. Not, however, until 1893 did

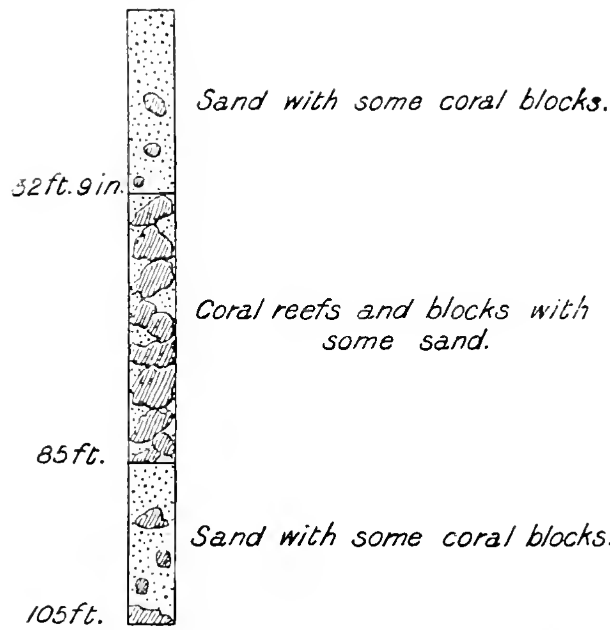


Fig. 1.—Structure of abandoned Bore-hole, Expedition 1896.

a project for such a survey become fairly launched, and then chiefly through the strenuous endeavours of Prof. W. J. Sollas, F.R.S., who succeeded in at last promoting a "Coral Reef Committee." Prof. T. G. Bonney, F.R.S., assumed the chairmanship, and on this body several of the most competent among English geologists, with other authorities, consented to serve. It is unnecessary to say that, whatever the latter-day millionaire may do for science, none made his appearance at this initial stage.

The primary idea was to investigate, by means of a boring, the depth and structure of an oceanic coral reef, and thus make it tell its life story. Ultimately it was decided to attack the problems surrounding the question at Funafuti, an island in the Ellice Group in the Pacific Ocean, and a comprehensive scheme for an exploring Expedition was drawn up in 1896, Professor Sollas being unanimously designated as leader. Although the difficulties that lay in front were by no means underrated at the commencement, yet the news of the failure of the first attempt in 1896 was indeed unwelcome. (Fig. 1.) However, nothing daunted, a second Expedi-

tion was organised in 1897, under the direction of Prof. T. W. Edgeworth David, of Sydney, and a third in 1898, with Mr. A. E. Finckh as leader, for the further prosecution of the work. The final result was the achievement of a drill boring to the extraordinary depth of 1114½ feet, and the bringing of a core, by which means the composition of an atoll in its zoological and chemical aspects has been actually determined. How rejoiced the great naturalist of Down would have been could he have lived to witness the realisation of his wish. We can picture his eagerness to write at once to Hooker, and to Wallace and Agassiz. His personal opinions regarding the development of coral reefs would not have weighed for an instant, since his open mind had already dictated the characteristic sentence, "if I am wrong, the sooner I am knocked on the head and annihilated, so much the better."

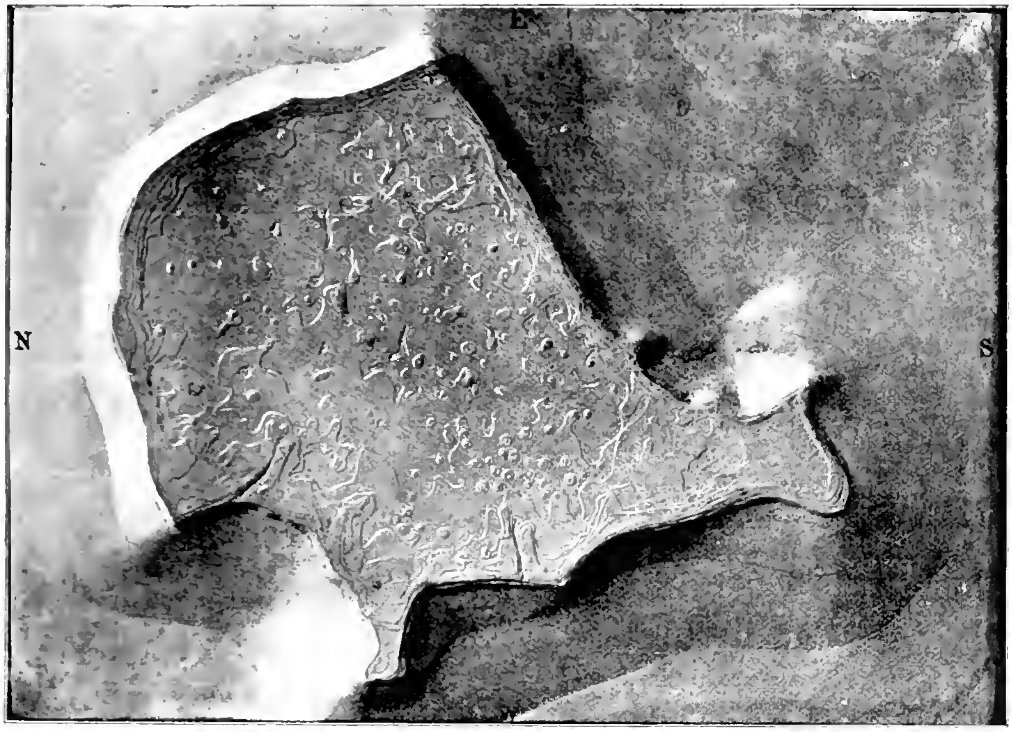


Fig. 2.—Model of Atoll, showing general shape and Submarine contour.

Although much scientific literature has centred around Funafuti in the intervening years, it has not been possible to pilot the whole scientific story of the borings


Fig. 3.—Hard Breccia Masses on Shore.

to completeness until to-day, but it is now told in a handsome monograph just issued by the Royal Society, to which source we are indebted for our illustrations.

The configuration of the atoll is seen on reference to the model (Fig. 2), and its fanciful resemblance to the shape of a human head (view from the compass letter S) has not escaped notice. The longest continuous stretch of reef is 16 miles in length, and the most elevated point above high water, 16 feet; while the general depth of the waters of the lagoon is about 20 fathoms. One peculiar feature of the atoll is its submarine cliff, re-

Fig. 4.—Hurricane Beach, Funafuti, and living "Lithothamnion" Reef.

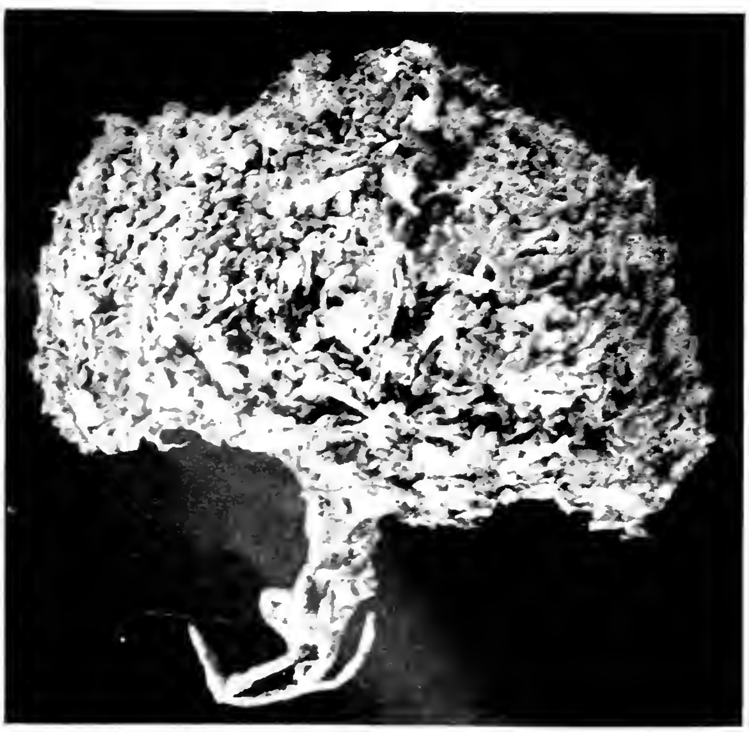


Fig. 5.—A Cluster of the alga "Halimeda."

garding which Professor Edgeworth David remarks that were the whole atoll elevated 140 fathoms, it would enable the portions above the sea-level to present a cliff face 300-600 feet in height.

Although we speak of Funafuti as a coral island, in its fauna corals are the accessory rather than the essential reef-builders, and of the latter none are more abundant and contributory to reef-rock than the calcareous algæ *Lithothamnion* and *Halimeda*. Indeed, a classification of the chief reef-forming organisms assigns their relative importance thus:—(1) Species of *Lithothamnion*, (2) *Halimeda*, (3) *Foraminifera*, (4) *Corals*. And Mr. Finckh, in a biological chapter, tells us, further, that a coral once established adds to the coral island by its growth only in the same way as a tree once established adds by its growth to the extent of a forest. In the living state and by itself it cannot form a solid mass; dead, however, its skeleton supplies material which the *Lithothamnion* and *Halimeda* unite together with the remains of other calcareous organisms to make reef-rock mounting thus "On stepping stones of their dead selves to higher things." (Figs. 3, 4.)

Some interesting experiments were conducted relative to the effect of exposure to the

sun's rays and the powers of endurance to heat of corals and of *Lithothamnion*, a point on which Darwin had speculated. It seems that except the *Porites*, all other forms of coral succumbed within two hours' exposure, and it was evident that the essential life-gift alike to coral and plant was a constant supply of fresh sea-water.

Among the contributions to the monograph certainly the most industrious of all is Dr. Hinde's report on his examination of thin sections of the materials obtained from the reef borings and those made beneath the floor of the lagoon. Upwards of 500 microscopic surface slittings were prepared for diagnosis in Professor Judd's geological laboratory at the Royal College of Science. As already mentioned, the main boring, begun in 1897, was taken down to 1114½ feet, and it may be added that the diameters of the cores brought up in the drilling apparatus were, top to 68 feet, about 4 inches; 68-210 feet, about 3¼ inches; 210 to boring limit, about 2¼ inches. All these cores ranged in length from 1 inch to 3 feet. Dr. Hinde supplies an elaborate description of a detailed inspection of the several lengths of core that were placed under examination for the detection of organisms, and we cannot do better than quote here Professor Judd's general conclusion thereon, namely, that "from top to bottom the same organisms occur, sometimes plants, sometimes foraminifera, and sometimes corals predominating; but in the whole depth bored the same genera and species of these various groups of organisms take their part in the building up of the mass." (Fig. 5).

A large amount of space would be necessary to even summarize the many points of research apart from boring and sounding operations embraced by this truly classic exploration in the far Pacific. There was made, however, we must not omit to mention, a magnetic survey by H.M.S. *Penguin* (Captain Field); a series of meteorological observations; and a thorough study of the natural history of the island of Funafuti.

The numerous helpers in the two continents have reason to be proud of the evidence of their long-continued efforts, and undoubtedly the scientific results of the survey will prove of the utmost value in current discussions which concern the present-day revised view of the development of coral reefs.

Modern Views of Chemistry.

By H. J. H. FENTON, F.R.S.

IT may happen that there are some of our readers who are interested in the study of Chemistry, but who have not had the time or opportunity of following the very rapid and important advances which have been made in the science, especially in the departments of physical and organic Chemistry. In the present articles, which are addressed to readers of this class, it is proposed to give brief sketches in outline of some of the more important developments which have occurred during recent years.

We will in the first place refer to the great changes which have occurred in our views with regard to the nature of solution and the chemical and physical changes which may take place in dissolved substances; the advance of knowledge in this department has resulted in what is sometimes called the "New Chemistry," which would scarcely be recognised as the same science by one who had been a good chemist twenty-five years ago, but who had not kept pace with the times.

It may be mentioned in passing that it was the custom formerly to restrict the term "solution" to liquid mixtures—that is to solids, liquids, or gases dissolved in liquids; but we may now speak of solutions of gases in solids and even of solids in solids; a solution is in fact, generally speaking, any homogeneous mixture of two (or more) substances in which the proportions may, within certain limits, be varied continuously. Usually one speaks of one of the constituents as the solvent and the other as the dissolved substance or "solute"; but this is only an arbitrary distinction. In the case of an aqueous solution of common salt, for example, we might regard the mixture either as a solution of salt in water or of water in salt; for if a dilute solution be sufficiently cooled it becomes saturated with respect to water, and solid water (ice) separates out, leaving a stronger solution of salt, just as when a very strong solution is cooled it becomes saturated with respect to salt, and the latter separates in the solid state, leaving a weaker solution of salt, *i.e.*, a stronger solution of water. It was at one time thought that solution consisted in a sort of loose chemical combination between the solvent and dissolved substance, and this idea seemed to be supported by the fact that many salts and other substances combine with water to form definite hydrates, which may be isolated in the crystalline form. But it does not follow that these hydrates continue to exist when the substance is in solution, and the probability is that, in dilute solution at any rate, they do not exist.

Certain membranes exist naturally, and may be prepared artificially, which will allow water to pass through them, but will not allow the passage of dissolved substances such as sugar, salt, &c. If now one separates a solution of sugar from pure water by means of a membrane of this kind water will pass both ways through the membrane, but more will pass into the sugar solution than out of it, so that its volume tends to become larger and the solution weaker. If, however, the volume of the solution is kept constant, that is, if it is not allowed to expand, the pressure will increase instead, and will continue to do so until a certain maximum pressure is reached. This maximum (osmotic) pressure depends upon the temperature, the strength (or concentration) of the solution, and the nature of the dissolved substance. It is found to vary with the temperature and concentration according to the same laws which regulate the pressure of a gas, and, further, the actual pressure produced is the same as that which would be exerted by the same substance (theoretically in the case of sugar) if it were in the state of gas at the same temperature and volume.

A large class of substances (such as sugar, urea, and most other organic substances) behave, therefore, in exactly the same way when dissolved in a solvent as they would in the gaseous state as regards the relations between temperature, concentration, and pressure—only that what we understand by "pressure" in the gas state must be interpreted as "osmotic pressure" in the case of solutions.

By making use of Avogadro's hypothesis—that equal volumes of gases contain, at the same temperature and pressure, the same number of molecules—we can compare the molecular weights of gaseous elements or compounds by weighing equal volumes of them under the same conditions; and now by extending this hypothesis to substances dissolved in liquids we can compare their molecular weights in a similar way. It may be done in the latter case by measuring (directly or indirectly) the

osmotic pressure which is produced at a certain temperature and volume by a given weight of the substance.

If we apply this method to the determination of molecular weights of substances in water solutions, it is found that, although most of the organic (and some inorganic) compounds give perfectly normal results—results, that is, which agree with vapour density determinations and with general chemical considerations)—most salts, acids, and bases give results which are apparently abnormal, the osmotic pressure produced being too high. A dilute solution of potassium chloride, for example, gives an osmotic pressure almost exactly double of that to be expected by the application of Avogadro's hypothesis. That is to say that one molecular weight of potassium chloride gives twice the osmotic pressure which one molecular weight of sugar (urea, &c.) gives under the same conditions.

It was suggested that this result might be explained by supposing that the salt is "hydrolysed" by the water—*i.e.*, that caustic potash and hydrochloric acid are produced. Since they would be formed in exactly equivalent quantities, it would not, of course, be possible to detect their presence by the ordinary tests. But such an explanation will not account for the fact that hydrochloric acid itself behaves "abnormally" also, giving about double the expected effect.

The theory of Arrhenius not only accounts for all these "abnormalities," but offers in addition a most elegant explanation of a large number of facts in connection with the behaviour of salts and other substances in solution, including the phenomena of electrolysis. This theory assumes that most salts, and the strong acids and bases, are largely if not entirely dissociated when dissolved in water (and in some other solvents) into constituent parts or "ions," and that these ions differ from the same substances, as we know them in the separated state, in that they are associated with enormous electric charges. A molecule of potassium chloride, for example, dissociates into an atom of potassium associated with a positive charge, and a chlorine atom with an equal and opposite negative charge. These charges are given up at the respective electrodes when the salt is electrolysed and the potassium and chlorine are obtained in their ordinary "neutral" state.

A revolutionary hypothesis of this kind was viewed, perhaps naturally, in the first instance with suspicion and dislike, and even at the present day it is not quite universally accepted, but the active opponents, at any rate those who have the courage of their opinions, are becoming daily few and far between. The application of this ionic dissociation hypothesis in explaining various well-known chemical phenomena is an extremely fascinating study and it is proposed to give various examples in illustration of the application at a future time. Just one may be mentioned here in conclusion.

A question which agitated the minds of chemists for a great number of years was of the following form: What happens when two different salts—say, sodium chloride and potassium nitrate—are mixed together in aqueous solution? Do they remain as they are or do they "change partners," forming sodium nitrate and potassium chloride? A large number of experiments were made with a view of throwing light upon this question, but in most cases the problem appeared to be incapable of solution. It was apparently of no use to attempt the isolation of the different salts since the equilibrium would be disturbed by their removal, and it seemed only admissible to employ methods which required no removal from or addition to the solution. Attempts were made, for example, to throw light upon the problem by observing the thermal, volume, or colour changes which occurred on mixing the solutions, and although a certain amount of information was gained by such methods, they were in most cases anything but conclusive.

This much-debated question then—which metal is united with which acid-radicle?—is (as a general case in dilute aqueous solutions) now at once disposed of by the ionic dissociation hypothesis, which gives the answer—No metal is united to any acid-radicle!

Wind-Driven Electricity Works.

By Dr. ALFRED GRADENWITZ.

PROFESSOR LATOUR, of the Askov Popular Academy (Denmark), has for some years been engaged on behalf of the Danish Government in investigating the problem of utilising wind power in connection with small electricity works. If, however, the dynamo be direct-coupled to the wind motor, the results obtained are unsatisfactory on account of the exceedingly variable speed of the wind. As pointed out in an address recently delivered by Professor Latour before the Copenhagen Technical and Hygienic Congress, he was met with difficulties in designing a suitable regulator for controlling the speed of the dynamo. At present, however, these difficulties appear to have been overcome, and an electricity central station near Askov has been worked with wind power for a year with satisfactory results.

The arrangement of a similar electricity works is represented diagrammatically in fig. 1. The regulating device itself is made up of two different parts. The mechanical regulating device is intended for maintaining at constant values the peripheric force transmitted to the belt disc of the dynamo. The two belt discs R R are mounted on a movable arm A, bearing a counterweight P. The resulting tension of the belt is thus kept constant, depending on the weight of the belt discs as well as on the counterweight P. The ratio of the resulting belt tension and the maximum peripheric force susceptible of being transmitted by the belts is, however, practically constant. The peripheric force transmitted by the wind motor to the belt disc R accordingly cannot exceed a given value, the torque of the dynamo remaining below a corresponding value. Any surplus energy developed by the wind motor is lost as heat with the friction of the belt. A constant torque of the dynamo axle will, however, correspond with a constant current intensity in the armature. In the case of the magnetising intensity employed, the load is in fact

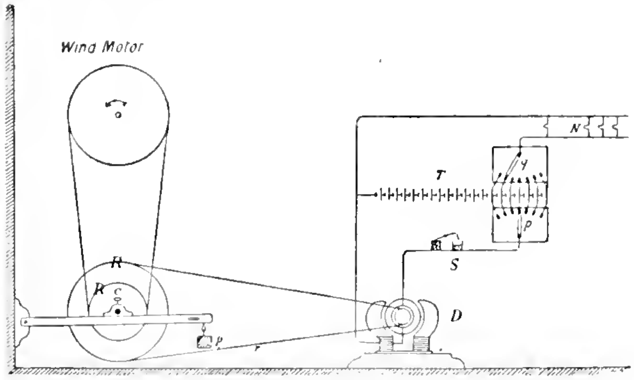


Fig. 1.

practically proportional to the speed, so that the intensity of the current may be regarded as constant. This is further demonstrated by the author's measurements.

The current from the dynamo is used to charge an accumulator battery represented diagrammatically in Fig. 1. The cut out switch F is closed, provided the current intensity be not inferior to its normal constant value. The dynamo D therefore works at a variable speed. In the case of the wind being so strong as to absorb part of the energy by the friction of the belt, the system will work in the following way: Assuming the accumulator battery to be nearly discharged and the crank of the cell controller to be adjusted for the total charge of the battery, the dynamo will run at a speed so high as to be quite sufficient to charge the battery with the normal current of a dynamo (*e.g.* 50 amp.). As the charge increases, the dynamo will automatically increase its speed and load so as to make the charging current constant. The cell-controller will have to be resorted to in charging in exceptional cases only—if, for instance, the charging and discharge of the battery takes place at the same time.

The electrical regulating device is situated in the interruptor S, being mainly an ordinary minimum current interruptor, disconnecting the dynamo as soon as the current decreases below the normal number of amperes. This arrangement is necessary to prevent the accumulator battery from being discharged through the dynamo when the strength of the wind is small. The interruptor, however, will automatically insert the current as soon as the wind again assumes a greater strength. To attain this result, the current interruptor is provided with a tension regulator, inserting the current as soon as the speed of the dynamo has sufficiently increased. In the case of variable strengths of the wind, the plant may thus accumulate any amount of wind available, the interruptor opening and closing the connections continually. On the switchboard there are in addition two ammeters and one voltmeter.

A small electricity works arranged in accordance with the foregoing principle has, as above mentioned, been in operation in Askov since the beginning of last autumn, supplying the inhabitants of the neighbouring communities with electric current. The constant normal current supplied by this installation is 60 amps. at tension of 220 volts. As a reserve, however, in cases of several days' calm weather, a petroleum motor had to be installed. The plant has so far given every satisfaction, requiring no superintendence worth speaking of. The man in charge of the machine was away for whole days, so that there was no supervision except in the morning and the evening. The capacity of the accumulator battery is sufficient to supply the maximum amount of energy required during 48 hours. As regards the economical side of the question: The first cost at Askov has been about 16,000 Kr. (a Kroner is about 1s. 1d.), out of which 3000 Kr. are set aside for the cost of petroleum motor. The electric current is supplied to consumers at the same price as in Copenhagen. The receipts for energy sold work out at about 2800 Kr., and the expenses at about 800 Kr. per year. There will thus remain 2000 Kr. for the amortisation of the plant, which is more than sufficient with a capital of 16,000 Kr. The price of energy could therefore be further diminished. In the case of small electricity works intended for the use of a limited number of houses, the petroleum motor may be replaced by a horse-driven contrivance. Moreover, in the case of the proprietor of the works being his own consumer, the consumption of current may be regulated according to the actual intensity of the wind; in the case of calm weather, there will for instance have to be no thrashing done, &c. The first cost will thus be considerably diminished; according to Prof. Latour's calculation, a plant suitable for a farm would be installed at a cost of 3000 to 4000 Kr.

The Works at Askov.

The Canals on Mars.

IN a communication to the Royal Astronomical Society on June 12, 1903, as reported in the *Observatory* for July, Mr. Maunder called in question the objective reality of the canals on Mars, explaining them away as psychological phenomena "due to the integration by the eye of markings far too small to be observed by the observer." He based his argument on the fact that copies of drawings of Mars without the canals, made by boys of from 12 to 15 years of age placed at various distances from the drawings, contained lines resembling canals amounting to five canals per head as a maximum at a distance of 25 feet, the diameter of the disk being about 6 inches. Unfortunately, the report gives us no information as to the closeness of coincidence of the lines with canals that have been actually observed, nor even as to the agreement between the lines drawn by different boys. It is difficult to see how the drawings to be copied could have contained actual Martian markings that were "far too small to be observed," whose integration produced lines in the positions in which canals have been observed; but if the drawings were not sufficiently accurate to show such markings, the lines must have been produced by markings peculiar to the several drawings, whose resemblance to anything on the planet is highly improbable. In drawing inferences from a comparison of artificial experiments with natural phenomena, it is certainly essential to the value of the results that the artificial and natural phenomena shall be substantially identical, and that the observations shall be made under practically the same conditions in both cases. On a later occasion, Mr. Maunder himself strenuously insists upon the necessity for a very close resemblance between the phenomena and between the conditions of observation in such cases. In criticising Mr. Lowell's application of the results of his experiments on the "visibility of fine lines" (the *Observatory* for September, 1903), Mr. Maunder says "there is actually no resemblance between the case of observing a wire in space and that of observing a line drawn on a surface"; nevertheless, he seems to find a sufficiently close resemblance between the observation of a flat picture (inaccurate, at best) with the naked eye in a

lighted room, and the observation of an illuminated ball surrounded by the blackness of night, seen through the mirage of its own atmosphere by means of a telescope. Those who draw conclusions from observations should be very careful in their reasoning, bearing in mind that induction, while a powerful instrument in the construction of theories, is absolutely useless in their proof or disproof. A theory of physical phenomena can be disproved only by showing that it leads by deductive reasoning to necessary conclusions that are inconsistent with observed facts. Mr. Maunder's theory may explain sufficiently well the lines on the copies of his drawings, but it no more suffices to disprove the objective reality of the canals observed on Mars than it does to prove that there are only five canals, as seen by his boys. The fact that an effect may be due to one cause, while it may certainly also be due to another, affords no presumption that it is due to the first rather than to the second, especially when the one explanation is based upon artificial experiments and the other is natural.

Mr. Maunder's argument assumes that the canals are seen as very faint lines, so faint that their existence is doubtful even to experienced observers; this may be true when they are observed through any but an exceptional atmosphere—and the atmosphere of Flagstaff is one of the exceptions. There, even under ordinary conditions, at the proper Martian season most of them are so easily and certainly seen that there is no reasonable doubt about them. Before Mr. Maunder ever discovered the psychical effect, Mr. Lowell was perfectly aware of it himself, and had studied it experimentally, which experiments he has continued to the present time, with the result that he finds a clear line of demarcation between confusion of real and imaginary up to a certain degree of definiteness of the real, and an instant consciousness of the difference between the two above that limit. The brain is not only conscious of the image, but directly conscious of reality as opposed to illusion. If Mr. Maunder's drawings had contained some canals for comparison with the imaginary lines, this difference would probably have been apparent.

The behaviour of the canals, their waxing and waning with the advance of the Martian seasons, is proof positive that they are not due to the integration by eye of *permanent* faint markings, and it is more difficult to account for the gradual and regular advance and retreat of such markings along the line of a canal than for the growth and decadence of the canal itself. Mr. Maunder's explanation seems to substitute an uncertain and almost impossible phenomenon for a very certain and probable one. From 8,500 determinations of the canals, Mr. Lowell has recently shown that they come into sight after the melting of the polar cap in times that are directly proportional to their distances from that cap measured in latitude. The enormous improbability of any such agreement in 375 drawings, the number he used, is so great as to run into the millions to one.

The logical conclusion of Mr. Maunder's argument, if valid, is that no faith is to be put in the reality of things seen, if anybody has ever been deceived in the appearance of such things. The scientific value of facts would then be liable to complete emasculation by the ignorance, carelessness, or malevolence of an observer. It is time an end should be put to the inquisitorial fashion of refusing credence to scientific discoveries until they shall have received the official recognition of the self-constituted authorities, especially when those authorities do not represent experts in the subject in question. That it is useless to continue the observation of planetary detail, because henceforth no reliance can be placed on what observers may tell us they have seen of such, can only be the doctrine of what may be called an "impressionist" school of science. If Mr. Maunder claims that his explanation is simply one mode of accounting for the appearance of the canals, he is practically throwing doubt upon their existence without taking the responsibility for it.

In the course of the discussion of Mr. Maunder's communication, Professor Newcomb said: "We all know how one improves by practice, and I think there is such a thing as improvement of the art of seeing things different from what they really are." This is a gratuitous slur upon scientific observation, to be justified only by the heat of a violent quarrel, and inexplicable under the present circumstances. Surely, Professor Newcomb cannot believe that the statements of an observer are any the less credible because he has had experience? No: these experiments show conclusively that observers must be trained to their work, that even descriptions of phenomena are of little value unless made by those who are experienced in observing phenomena of the kind described. The reports of such observers must be accepted as truly indicative of fact until they shall have been proved to be false, which can be done only by direct appeal to observation. WILLIAM EDWARD STORY.

Worcester, Mass., U.S.A., January 2, 1904.

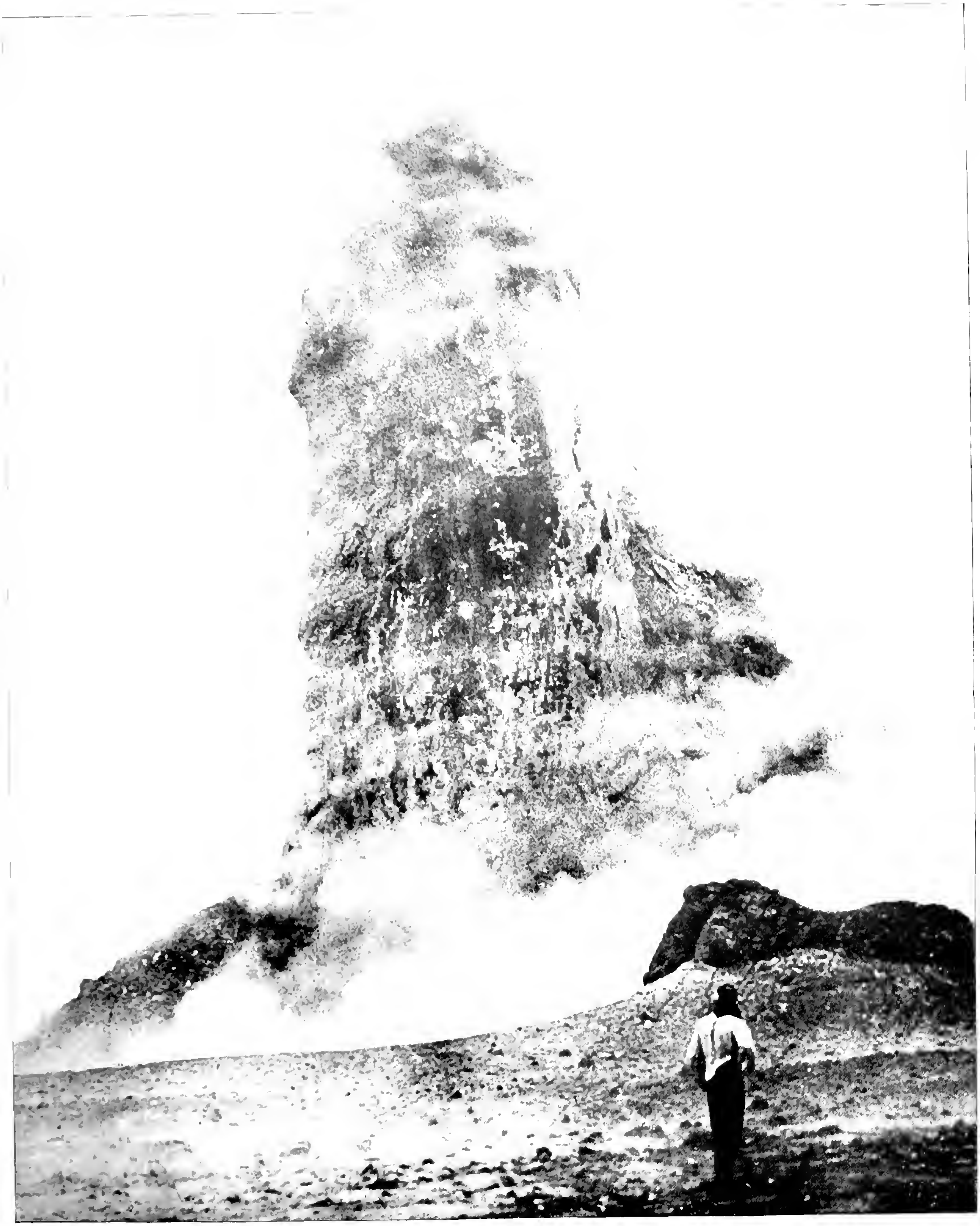
[Mr. Story criticises the paper communicated by Mr. Evans and myself to the R A S. without first having done us the honour of reading it. This method has some disadvantages; one being that many of Mr Story's remarks have no bearing at all on the questions with which we actually dealt Want of space prevents my dealing with the details of Mr. Story's paper in the present number of "KNOWLEDGE," but if the subject sufficiently interests its readers I may return to it on a later occasion For the present, it is sufficient to enter a strong protest against Mr. Story's quite uncalled-for attack upon Professor Newcomb. —E. WALTER MAUNDER.]

The Obelisk of Mount Pelee.

WE reproduce herewith a remarkable photograph taken by Mr. E. O. Hovey, for which we are indebted to our contemporary, the *Scientific American*. It represents one of the most peculiar and interesting phenomena of the recent eruptions of Mount Pelee. This was the growth of the tooth-like column of rock which arose out of the centre of the crater. It was first observed (by Professor Lacroix) in October, 1902, amid the dense smoke and steam overhanging the mountain. It was then estimated to be about 205 feet above the rim of the old crater. But subsequent observations proved it to be steadily growing, and after some months had attained a height of over 1000 feet. Professor Heilprin noted a growth of about 20 feet in four days.

Various explosions and movements of the earth altered the relative height of the obelisk. It rose and fell and large portions became detached. Bit by bit it then receded again, sinking as much as 150 feet during one night, but frequently rising again temporarily. This continued during many months, till finally it disappeared within the cone.

The cause of this curious apparition can but be vaguely surmised. It has been suggested that the vent of the volcano in olden days had become filled with solidified lava, and when the first outbreak occurred this whole mass was raised bodily up, as a cork is forced upward from a bottle.



The Obelisk of Mont Pelée.

The Face of the Sky for March.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.48, and sets at 5.38; on the 31st he rises at 5.41, and sets at 6.24.

The vernal equinox occurs on the 21st, when the Sun enters the Sign of Aries at [illegible] a.m. and Spring commences.

Sunspots may frequently be observed, and for plotting their positions the following table may be used.

Date.	Axis inclined to W. from N. point.	Centre of disc, S. of Sun's equator.
Mar. 1 ..	21° 15′	7° 14′
„ 11 ..	24° [illegible]	7° 12′
„ 21 ..	25° 31′	7° 7′
„ 31 ..	26° 21′	6° 5[illegible]′

The Zodiacal light should be looked for in the west for a few hours after sunset.

THE MOON:—

Date.	Phases.	H. M.
Mar. 2 ..	Full Moon	2 48 a.m.
„ [illegible] ..	Last Quarter	1 [illegible]1 a.m.
„ 17 ..	● New Moon	5 [illegible] a.m.
„ 24 ..	First Quarter	[illegible] 37 p.m.
„ 31 ..	Full Moon	[illegible] 44 p.m.

The Moon is in perigee on the 1st and 26th and in apogee on the 14th.

Occultations.

The following are the more interesting occultations visible at Greenwich during convenient hours; it will be seen that on the 22nd the Moon is in the Hyades:

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Angle from N. point.	Angle from Vertex.	Reappearance. Mean Time.	Angle from N. point.	Angle from Vertex.	Moon's Age. d. h.
March 22 ..	[illegible] Tauri ..	[illegible]	10.0 p.m.	131	90	10.41 p.m.	223	1[illegible]4	[illegible] 16
„ 22 ..	75 Tauri ..	5·3	10.4 p.m.	30	350	10.35 p.m.	[illegible]24	2[illegible]	[illegible] 16
„ 22 ..	D.M. [illegible] ..	6·5	10.4 p.m.	84	43	11.1 p.m.	2[illegible]	2[illegible]	[illegible] 16
„ 22 ..	B.A.C. 1[illegible] ..	[illegible]	10.46 p.m.	56	41	11.[illegible] p.m.	2[illegible]	2[illegible]	[illegible] 17
„ 23 ..	111 Tauri ..	[illegible]·2	10.6 p.m.	70	[illegible]	11.1 p.m.	2[illegible]	2[illegible]	6 16
„ 25 ..	[illegible] Geminorum ..	[illegible]	9.2 p.m.	108	8[illegible]	10.11 p.m.	2[illegible]2	23[illegible]	8 15

THE PLANETS.—Mercury is in superior conjunction with the Sun on the 26th, and throughout the month is too near the Sun for observation.

Venus is an inconspicuous morning star during the month; also, as she only precedes sunrise by about an hour, she is badly placed for observation, and is becoming more unfavourably situated as she is approaching conjunction with the Sun.

Mars sets about 2 hours after the Sun on the 1st, and about 1½ hours on the 31st; on account of his small angular diameter, he is an insignificant object in the western sky shortly after sunset.

Jupiter is in conjunction with the Sun on the 27th, and therefore is only visible during the early part of the month after sunset.

Saturn is a morning star rising at [illegible] more than an hour before the sun.

Uranus rises after midnight and is situated rather low down in the sky near the star 4 Sagittarii.

Neptune, as will be seen on reference to the chart in the January number, is about midway and 10′ south of the line joining the stars η and [illegible] Geminorum.

Telescopic Objects:—

Double Stars.—γ Leonis, X.[h] 14[m], N. 20° 22′, mags. 2, 4; separation 3″·8. In steady air, the prime requisite for double star observations, this double may be well seen in a 3 in. telescope with an eyepiece magnifying about 30 to the inch of aperture, but on most nights one with a power of 40 is better.

The brighter component is of a bright orange tint, whilst the fainter is more yellow.

ι Leonis, XI.[h] 19[m], N. 11° 5′, mags. 4½, 7½; separation 2″·2. A pretty double of different coloured stars, the brighter being yellow, the other blue. This object requires a favourable night and a fairly high power on small telescopes.

α Leonis (*Regulus*) has a small attendant about 180″ distant, and of the 8·5 magnitude, and easily seen in a 3-inch telescope.

α Canum Venat. (*Cor Caroli*), XII.[h] 52[m], N. 38° 52′, mags. 2·5, 6·5, separation 20″; easy double, can be seen with moderately low powers, even in 2-in. telescopes.

Meteor Showers:—

Date.	Radiant. R.A. h. m.	Radiant. Dec.	Radiant. Near to.	Characteristics.
Mar. 1–4	11 [illegible]	+ 4	τ Leonis	Slow; bright
„ 14	16 40	+ 54	η Draconis	Swift
„ 24	10 44	+ 58	β Ursae	Swift
„ 28	17 32	+ 62	ζ Draconis	Rather swift

THE STARS.—About the middle of the month at 9 p.m. the positions of the principal constellations are as follows:

ZENITH . No bright constellations in the zenith.

SOUTH . Cancer and Hydra on the meridian; Gemini high up, *Procyon* and *Sirius*, all a little to the W. Orion is to the S.W., and Leo (*Regulus*) to the S.E., high up.

WEST . Taurus, Aries near setting. Auriga (*Capella*) high up. To the N.W. Perseus, also Andromeda low down.

EAST . Virgo (*Spica* rising), Bootes (*Arcturus*). To the N.E. Ursa Major high up, Corona, Hercules, and *Vega* low down.

NORTH . *Polaris*; to the right, Ursa Minor, Draco; below, Cygnus, Cepheus; to the left, Cassiopeia.

Minima of Algol may be observed on the 16th at 0 h. 7 m. a.m., 18th at 8.56 p.m., and 21st at 5.45 p.m.

A Photographic Atlas of the Moon.

VOLUME LI. of the Annals of the Harvard College Observatory is devoted to a photographic atlas of the Moon. This marks an epoch in selenography, not only because it is the first complete photographic atlas of the Moon yet published, but because every part of the Moon is represented under five different conditions of illumination sunrise, morning, noon evening, and sunset. This fivefold presentation is of the greatest importance to the selenographical observer, as the change in appearance of most of the lunar formations during the course of the lunar day is so great that a photograph taken at one time becomes almost unrecognisable if compared with the Moon at another. It constitutes a record in another particular, namely, that the entire series of photographs were taken within the short period of seven months. Yet a third feature of the atlas lies in that this was the first time that a long focus telescope has been successfully employed in this department of astronomy. Such telescopes have been employed with success upon the corona in recent eclipses, but their application to the systematic record of the Moon was a new departure.

This work is the result of one of those enterprises which the measureless energy of Prof. E. C. Pickering, and the corresponding munificence of the American public, have brought to completion within the last few years. An expedition under Prof. W. H. Pickering, who has had much experience of the superb observing conditions both of Arequipa and Arizona, was sent out from Harvard College to the Island of Jamaica, and reported so satisfactorily on the "seeing," that at the end of 1900 he took out there a photographic O.G. of 12-inches aperture, and 135 ft. 4 in. focal length. This was set up at Mandeville, 2080 feet above the sea level, and used as a fixed telescope in conjunction with a heliostat. The seeing did not prove to be quite equal to expectation, and a yet more serious drawback was experienced in the want of flatness of the heliostat mirror. In most cases, therefore, the aperture of the photographic telescope had to be diminished to 6 inches, and the exposures lengthened accordingly.

From the photographs taken by the expedition, 80 were selected, each 9 in., by 4 in., to form the complete lunar atlas, the Moon being divided for the purpose into sixteen different regions, each shown, as noted above, under five different conditions of illumination. The parallels and meridians were laid down on a photograph of the full Moon, taken on 1901, August 29, the positions derived by Franz from measures of five negatives of the full Moon taken at the Lick Observatory being taken as standards. Professor Franz's positions are undoubtedly the most accurate yet published, and Professor Pickering devotes the last chapter of his book to an inquiry as to whether the altitude of a lunar mountain can be deduced from the discordances between its apparent co-ordinates on the lunar surface, as measured under different conditions of libration. The result, however, is not very encouraging, the displacement to be measured being very nearly of the same order as the errors of observation, as Mr. S. A. Saunder has recently pointed out. and a far more extensive series of measures than any yet published are required in order to satisfactorily solve the question of lunar altitudes. The third chapter is devoted to the consideration of lunar change; the cases of Eratosthenes, Plinius, and Pallas being lightly alluded to, whilst Linné, Plato, and Messier, with its companion Messier A, are treated with considerable detail. The enlargements of Plato and Messier, especially the former, by no means justify Professor Pickering's claim that "these are the first photographs published, so far as I am aware, showing the details of the floor so plainly that they may be clearly distinguished." They are certainly not equal to the photographs of Plato in MM. Loewy and Puiseux's Atlas. Another point on which Professor Pickering lays himself open to some criticism is the uncompromising way in which he habitually speaks of bright spots on the Moon being "snow," or "hoar frost," or "ice," whilst dark spots are often as unhesitatingly described as "patches of vegetation." While not wishing to ignore the very considerable amount of evidence which Professor Pickering has elsewhere presented in favour of these, his views, they cannot yet be regarded as more than mere opinions, and it is hardly legitimate for him to express himself as if they were altogether beyond challenge.

* *Observatory*, 1904, February, p. 90.

"Annals of the Astronomical Observatory of Harvard College," Vol. LI., a Photographic Atlas of the Moon, by William H. Pickering, Cambridge, Mass. Published by the Observatory, 1903.

Large v. Small Telescopes on Planets.

TO THE EDITORS OF "KNOWLEDGE."

SIRS,—I was much interested in Mr. A. Stanley Williams's letter in the current number of "KNOWLEDGE." No doubt there is reason in his suggestion. But to my mind there is a much stronger reason for the greater relative defining power of small telescopes when used on planets over their performance on double stars, which seems to be generally overlooked.

On double stars, I believe, the rule of 4·56 seconds of arc divided by the aperture is generally accepted as the limit of the telescope's dividing power, and this agrees very well with theory. But it only holds good when the objects to be separated are sufficiently bright to cause strong interference effects. Now the details on a planet are seen against a background nearly as bright, and except at the edges the contrast is very feeble, so interference phenomena are less appreciable. Therefore I hold that the 4·56 seconds-over-aperture rule does not apply. Mr. A. Stanley Williams, in his first paragraph, also seems to imply a doubt of ordinary rules holding for *large* areas, but I maintain that small telescopes will separate *details* on a planet very much closer than the above rule would allow. And so would, and sometimes does, a comparatively large aperture, but the magnification needed to tone down the light to utilize the larger aperture needs better atmospheric conditions, so that it is comparatively rarely that such apertures can be used with full effect. If we take 40 diameters to the inch of aperture as about the best ratio for viewing, say, Mars, one will on most nights find the seeing good enough to use the 120 needed by a 3-inch. But apply that rule to the 40-inch Yerkes, and how often can a power of 1600 be employed to advantage?

A few years ago I made some experiments to test the separating power of 1 inch of aperture directed to black spots on white paper. I found that 1 inch would divide dots separated not more than 1 second of arc, and lines 0·7 second apart; and that it would show a single black line 0·8 second in width, which was, of course, separating white areas divided by that amount only. I think these experiments, which can readily be repeated by anyone who wishes, show that when interference effects are negligible, one may expect a telescope to go far beyond the usually accepted limits. But if more were needed, Mr. and Mrs. Maunder have supplied it in the paper published last July in the B.A.A. Journal alluded to by Mr. Williams in his letter to "KNOWLEDGE." There they show that a black line on unglazed paper was seen *sharply defined* with the unaided eye under an angle of only 2·8 seconds of arc. Taking the pupil of the eye when fully dilated at the extreme of one quarter of an inch, this is equivalent to 0·7 second of arc for 1 inch, which agrees well with my own experiments detailed above, though I consider it much more noteworthy, as the retina is composed of hexagons that at the nodal point of the lens system of the eye subtend an angle of about 23 seconds of arc, and that such a coarse structure should show a line only 2·8 seconds wide as sharply defined seems to bear out what Mr. Maunder says in his last paragraph, that: "A straight line is that which gives the least total excitement in order to produce an appreciable impression, and *therefore* the smallest appreciable impression produces the effect of a straight line."

H. WAKE.

Whitehaven, January 11, 1904.

NOTES.

ASTRONOMICAL.

Mr. Denning's Observations of Mars in 1903.

IN the *Astronomische Nachrichten*, No. 3920, Mr. F. W. Denning gives the main results of his observation of Mars with a 10-inch reflector, in the Spring of 1903. The powers that he used ranged from 252 to 488, but the one most commonly employed was 312. He noted that occasionally there were decided changes in the visible appearance of certain markings, and these changes were obviously not due, either to uncertain seeing, or to the varying inclination of Mars, but, in the observer's opinion, to local vagaries in the Martian atmosphere. Thus, on May 6 and 7, he saw a white band dividing the canal Nilus, not seen on March 31 or April 2, and not shown on the charts. Again, on May 21, the northern region of the Syrtis Major was very dark, with a white cloud on its southern edge, but on May 23 and 24 the whole Syrtis Major was very faint, as if veiled by the cloud spreading northwards. As regards the "canals," Mr. Denning says: "A large number of irregular dusky streaks (canals), different in tone and direction, were observed. Some of these were very distinct, as, for example, Nilosyrtis, Protonilus, Indus, Ganges, Cerberus, Casius, &c., while others, as Phison, Euphrates, Gehon, were feeble or extremely faint and delicate. Many of them were knotted or strongly condensed in places, and particularly so at those points where either a junction or intersection of two of them occurred." Mr. Denning considers these streaks as certainly objective. He says that they were single, though in a few instances two of them were placed tolerably near together, running in approximately parallel directions. He is emphatic that the "prolific system of double canals delineated by some observers had no existence" during the period of observation, as far as his eye and telescope could determine.

Comparing these recent observations with those made in February, 1869, Mr. Denning deduces from 12,136 rotations of Mars the value 24 h. 37 m. 22·7 s. for the rotation period.

The Double Canals of Mars.

Mr. Lowell, in Bulletin No. 5 of his Observatory, gives evidence against the hypothesis that the gemination of the Martian canals is an interference effect. If it were so, the width between the two components of a double canal should vary inversely as the aperture. To test this, Mr. Lowell observed a number of double canals with the full aperture of his telescope (24 inches), and then with that aperture reduced to 18, 12, and 6 inches. His measures of the drawings made under these several conditions showed that the apparent angular separation did not increase as the aperture was diminished; that the separation was invariable within the limits of observation for any particular canal, but differed for different canals, bearing no relation to the width of an interference pair of lines.

Mr. Lowell's Observations of Venus in 1903.

In Bulletin No. 6, Mr. Lowell classes the markings to be made out upon Venus under two heads. The first includes the collar round the south pole and the two spots on it, and the nicks inward from the terminator. Of these Mr. Lowell states he has always been certain, and "they alone are sufficient to show that the planet's rotation is an affair of about 225 days." The second class include the long shadings from the centre of the disc to the terminator, and of these, also, Mr. Lowell asserts "the objectiveness beyond the possibility of illusion." It will be seen that in this assertion Mr. Lowell is withdrawing his withdrawal of these markings which he published some eighteen months ago in the *Astronomische Nachrichten*, No. 3823. Mr. Lowell further adds that these streaks "bear no resemblance whatever to the 'canals' of Mars. They are faint streaks or spots. . . . They are not of even width, are not dark, and sharp cut. . . . Further-more, they are of a much higher order of difficulty. Unless the conditions of visibility are such as to show an observer the 'canals' of Mars with ease and certainty, it were useless to attempt this much harder planet." But in 1897, Mr. Lowell wrote in the *Bulletin de la Société Astronomique de France*: "Les configurations ont toujours été très nettes, aussi nettes en vérité que celles de la Lune." In *Popular Astronomy* for December, 1896, he wrote: "The markings are both distinct and well defined; their contours standing out sharply against the lighter parts of the disc. . . . The seeing must be distinctly bad to have the more prominent among them not discernible." This would seem to show that the definition at Flagstaff, Arizona, has changed seriously for the worse in the last seven years, whilst a comparison of the drawings of Venus, given in the Bulletin, with those of Mars, such as in *Popular Astronomy* for April, 1895, would not lead to the conclusion that there was any essential difference between the streaks on the two planets.

Calcium and Hydrogen Flocculi.

A memoir of quite exceptional interest is given on the subject by Professor G. E. Hale and Mr. Ellerman in Volume III., Part I., of the *Publications of the Yerkes Observatory*. Its subject is the minuter study of the surface of the sun by means of the spectroheliograph. The first point brought out is the essentially granular structure of the calcium flocculi, the entire surface of the sun showing a fine mottling when photographed on the bright K-line. The next point is the study of these calcium clouds at different levels, the result of the examination bringing out in a striking manner the way in which the calcium bright clouds expand as they rise higher. The detection of the dark hydrogen flocculi is another feature, and the fact that they often correspond, though not precisely, with the bright calcium flocculi. Last of all the discovery of dark calcium flocculi was established, and the necessity for further work with spectroheliographs of much higher dispersion, and working upon larger images of the sun, is insisted upon. The memoir is illustrated by fifteen extremely fine photographic plates.

The Nebulae.

The *Nineteenth Century and After* for February contains an article on "The Nebulæ," by the Rev. Edmund Ledger, Gresham Lecturer on Astronomy, which summarises with admirable clearness and precision, the state of our present knowledge respecting these mysterious objects, and the connection with them of the stars.

ZOOLOGICAL.

AT the meeting of the Geological Society held on January 20 Dr. A. Smith Woodward, of the British Museum, definitely determined the systematic position of the cretaceous fishes of the genus *Ptychodus*, whose large, quadrangular, ridged crushing teeth are such familiar objects to collectors in the chalk-pits of the south-east of England. It has long been known that *Ptychodus* was an elasmobranch fish, and Dr. Woodward himself had some years ago pointed out the probability of its being a ray, or skate, rather than a shark. The truth of this conclusion is fully demonstrated by a specimen of the jaw cartilages recently discovered near Lewes, which serve to show that these fishes were allied to both the eagle-rays and the sting-rays, and probably, therefore, the ancestral type of both. A photograph was shown at the meeting of a splendid American specimen of the dentition of *Ptychodus*, with the teeth in their natural position, forming longitudinal rows.

Fossil Birds.

Certain fossil bird remains were discussed by Dr. C. W. Andrews at the meeting of the Zoological Society held on

January 19. From Madagascar the speaker described a pelvis and thigh-bone of an ostrich-like bird closely allied to the extinct roc (*Æpyornis*) of that island, but regarded as generically distinct, under the name of *Mullerornis*. Much greater interest attached to a fragment of another bird of the same group from the Eocene strata of the Fayum district of Egypt, for which the name *Eremornis* was suggested. Possibly the discovery of this specimen might serve to demonstrate that all the ratite birds have a common ancestry, and are not, as some suppose, isolated members of a number of distinct groups which have lost the power of flight independently of one another.

A Sub-Species of Giraffe.

At the meeting of the above-named Society, on February 2, the local sub-species of giraffe formed the subject of a communication by Mr. Lydekker. It was shown that, as in the case of the bonte-quagga, or Burchell's zebra, a number of local forms readily distinguishable by their colour and markings, and (in the case of the giraffe) to some extent also by differences in the skull, are recognisable as we proceed from north to south down the eastern side of the Continent. In both instances it seems advisable to regard their local forms as races, or sub-species, rather than species. The northern forms are characterised by the presence of a large frontal horn and the white legs; but, as we proceed south, the median horn gradually becomes reduced to a mere boss, while the legs acquire spots right down to the hoofs. In the latter respect giraffes show a modification, exactly the opposite of that presented by the bonte-quaggas, in which the legs lose their stripes as we proceed south. Some of the East African giraffes are very remarkable, developing, in certain instances, rudimentary horns on the occiput, or over one eye, or displaying a marked sexual difference in colour. A race from the south of Lada was named in honour of Major Powell-Cotton, the celebrated explorer, and a second, from the Northern Transvaal, after Mr. Rowland Ward, of Piccadilly.

Cachalot Whales.

In the *Field* of January 3 reference is made to the occurrence of quite a number of sperm-whales, or cachalots, in the North Sea and North Atlantic; no less than seven adult bulls being definitely known to have been captured. As a rule, these whales are confined to tropical and subtropical seas, only a few old bulls occasionally straggling northwards. In the present instance a whole herd must have thus wandered out of the proper latitude. Recently Sir William Turner has recorded the capture of an old bull in the Shetlands in 1901, also mentioning that a herd was seen off the Faroes in 1899; while in the *Field* of January 30 Mr. T. Southwell refers to accounts of herds of these whales straying northwards in 1723 and 1752-53.

The Primeval Instincts.

A discussion has been going on in the columns of the *Field* as to the reason why horses when getting up from the recumbent posture raise themselves first on the fore-limbs while ruminants do so on the hind-limbs. It appears that tapirs, apparently rhinoceroses, and swine follow the horse-fashion; an association which demonstrates that the movement is not dependent on the presence of a third trochanter on the femur of the Perissodactyla (horses, tapirs, and rhinoceroses). One writer has suggested that the ruminants' mode of rising is for the purpose of bringing the horns into action for defence as soon as possible, but against this is the case of the rhinoceroses. Possibly the raising of the hind-legs first may be connected with the function of rumination and the complex form of stomach correlated therewith. One correspondent stated, however, that an ass rises like a ruminant, which, if true, upsets all theories.

New Mammals.

An instance of the pace at which American naturalists are increasing zoological nomenclature is afforded by a paper by Dr. D. G. Elliot recently published by the Field Columbian Museum of Chicago, in which no less than twenty-seven apparently new forms of mammals are described. Hitherto there has been supposed to be only a single species of glutton, or wolverine, but the author describes the Alaskan representative of that animal as new, under the name of *gulo luteus*. A new race of bighorn sheep (*Ovis canadensis cremnobates*) is also recorded from the San Pedro Martir Mountains of Lower California and Mexico.

Bird Migration.

Mr. W. Eagle Clarke, who is well known as an authority on the subject of the migration of birds, made a month's stay last autumn on the Kentish Knock Lightship, and the results of his valuable observations are detailed by him in the *Ibis*. It required a good deal of courage to brave the hardships and discomforts inseparable with life on a lightship 21 miles from the nearest point of land, but Mr. Clarke was so engrossed with watching the birds which passed the ship by day and were lured to its light by night that he seems to have hardly noticed the discomforts involved. Apart from the valuable details regarding the various species of birds migrating and the directions in which they were travelling, as well as many other points which we have not space here to discuss, Mr. Clarke makes some remarks of high importance with regard to some of the phenomena of general interest connected with bird migration. As an explanation of how birds find their way during migration it has been suggested that the great height at which they fly enables them to see enormous distances. But Mr. Clarke, while not denying that birds sometimes do migrate at great elevations, disposes of the theory that they depend on this means for finding their way. During all the time he was on the Kentish Knock Lightship the migrants of every species flew close to the water. Yet whatever the weather or state of the sea they kept a straight and apparently unerring course for the coast 21 miles distant. Mr. Clarke reaches the conclusion from this and other facts that birds are endowed with a sense of direction. Such a statement is, of course, in no way an explanation of the mystery as to how birds find their way, since we have no conception of the nature or workings of such a "sense." But the evidence that they do not find their way by sight is of the utmost importance. Those interested in bird-migration should not fail to read Mr. Clarke's latest and very valuable contribution to our knowledge of the subject.

Burrowing Fishes.

In *Fasciculi Malayensis*, a publication devoted to the description of the results of a recent expedition to the Malay Peninsula, a writer records a remarkable habit on a part of one species of the mud-haunting fishes of the genus *Periophthalmus*. These fishes make burrows in the mud, and retain a pool above the same, by preventing the water from flowing away during low tide by means of a circular well built by themselves.

One of the most remarkable palæontological discoveries is recorded from North America, where an Eocene lemur is believed to be allied to the curious aye-aye (*Chiromys*) of Madagascar. The extinct form is named *Parachiromys*.

Papers Read.

In addition to those already mentioned in special paragraphs, reference may be made to the following zoological papers read at various scientific societies. At the Linnæan on December 17, Mr. H. J. Fleure discussed the origin and evolution of the gastropod molluscs known as *Docoglossa*, of which the limpet is a familiar example. At the same Society on January 21, the Rev. T. R. R. Stebbing read a paper on the Crustacea obtained during surface dredging from H.M.S. *Research*, in the Bay of Biscay, during the summer of 1900. On January 19, before the Zoological Society, Mr. O. Thomas described a new subspecies of the aoul (*Gazella Sœmmeringi*) from North-East Africa. At the same time Mr. G. A. K. Marshall presented a monograph of the beetles of the genus *Hipporhinus*. Dr. W. Kidd called attention to the importance of the arrangement of the hair and the distribution of hair whorls in the classification of mammals. Dr. W. G. Ridewood described the skull of the giraffe, as seen in vertical transverse sections; and Mr. F. E. Beddard read a note on the brain of two lemurs. At the meeting of the same Society on February 2, in addition to Mr. Lydekker's paper on giraffes, a communication was received from Mr. O. Thomas on a collection of mammals from Namaqualand, including a new species of strand-mole

Bathygagus); and Mr. Beddard discoursed on the arteries of the base of the brain in certain mammals. Two papers by Mr. G. A. Boulenger were also taken at the same meeting, the one dealing with three new fishes from the Niger, and the other with the type specimen of the West African cat-fish known as *Clarias lazera*. At the meeting of the same Society, held on February 16, Mr. C. Crossland presented the third instalment of a dissertation on the marine fauna of Zanzibar and British East Africa, dealing in this instance with the polychætous annelids; and also a second paper describing a collection of the same group of organisms from the Malay Peninsula. The third paper, by Sir C. Eliot, dealt with certain nudibranchiate molluscs from Zanzibar and British East Africa.

A New Gazelle from the White Nile.

Considerable interest attaches to the description by the Hon. Walter Rothschild, in *Novitates Zoologicae*, of a fine new species of gazelle from the banks of the White Nile, which it is proposed to call *Gazella albonotata*.

BOTANICAL.

HERR LINDEMUTH, of Berlin, has published in *Gartenflora*, 1903, Heft 18 and 23, the results of his experiments on the propagation of plants by means of their leaves. Horticulturists have long been accustomed to use this means of propagation in a few plants, notably in the *Gloxinia* and certain Crassulaceæ, among which *Bryophyllum calycinum* is a well-known example. It was, however, probably not suspected that the leaves of so many plants could be made to produce roots. In his first communication Herr Lindemuth gives the names of twenty-eight species, of nearly as many different genera, in which his experiments have been successful. These include such plants as the Foxglove (*Digitalis purpurea*), the Musk (*Mimulus moschatus*), the Tomato, and the Vine. The leaves of thirteen species, including the Potato, Monkshood (*Aconitum Napellus*), and the common bedding Geranium (*Pelargonium zonale*) refused to root at all. Usually the roots were produced quickly—in the Vine in sixteen days, in *Veronica* in seven days, and in the African Marigold in eight days—but the amount of time required, and, indeed, success at all, was shown to depend very much on the season when the experiments were made. Thus, in the Vine, roots were developed in sixteen days in August; but complete failure resulted in September, when the leaves perished. In his second communication, the author records success with thirty-four additional species, including three of those with which he had met with failure before. The results so far obtained show that few of the leaves thus experimented on will form buds, only five having done so. In the case of a species of *Citrus*, the leaves rooted and persisted for months and even years without any further development.—S. A. S.

Recent Research in Agriculture.

MR. HALL, the Director of the Rothamsted Experimental Farm, lecturing at the Royal Institution on "Recent Research in Agriculture," dealt with the growth of wheat, still an important crop in Great Britain, despite the fact that the area under wheat has shrunk from more than four million acres in 1860 to less than 1,500,000 at the present time, and that we only now produced about seven million quarters, and had to import more than 25 million quarters. The English yield averaged, however, more than 31 bushels per acre, considerably greater than that of any other country, and double or treble that of the chief countries who send us wheat. The lecturer then showed, by examples drawn from the Rothamsted experiments, that the production of wheat could be greatly raised by the use of manures, but that this process soon ceased to be profitable—"high farming is no cure for low prices." A further difficulty to be faced by the English wheat grower is the comparatively low price of this product, the best Manitoba or Russian or Argentine wheat realising 20 to 25 per cent. more than the best English wheat. This difference of price is due to the greater "strength" of the flour made from such foreign wheats, meaning by "strength" the capacity to make more and larger loaves for equal weights of flour used. The lecturer illustrated the point by exhibiting loaves baked from equal weights of English and American flour, the American one being decidedly larger and more attractive in appearance. For some time the lecturer had been concerned with an enquiry initiated by the National Association of Millers, and helped by the Board of Agriculture, as to the conditions which brought about "strength" in flour, and how English wheat could be improved in this respect. Climate being one of the chief factors, the lecturer contrasted the English climate with that of the Hungarian Plain and of the North West. The development of wheat, the rate of formation of the grain, and the migration of the nitrogenous constituents into the grain was then studied at Rothamsted, and compared with similar results obtained in Hungary; all tending to show that strength is associated with a short period of ripening. Strength is dependent on the nitrogenous content of the wheat, but the attempts to correlate it more exactly with total nitrogen, with gluten, or with the ratio between gliadin and glutenin, as certain French and American chemists have done, fail to show consistent results. Climate is not, however, everything in causing strength, for even among English wheats some are much stronger than others. Certain foreign varieties also when introduced into this country retain to a very considerable degree their strength, at any rate for three or four years. However, they generally give crops considerably below the English standard, though for late spring sowing some of the best, like No. 1 Hard Manitoba, are probably equal to any English varieties. As "strength" is a quality inherent in the variety, it is capable of improvement by cross-breeding and selection, and a considerable amount of very promising work has already been done in this direction, the desideratum being increased strength with the cropping powers of the best English varieties. The lecturer exhibited various loaves made from English and foreign varieties of wheat grown in this country to illustrate the foregoing points.

PHYSICAL.

Photography in Natural Colours.

THE principal novelty of a process for obtaining photographs with natural colours, just brought out in Berlin, is the fact that any ordinary negative may be made to give chromatic prints with the original colours. Suppose a view of a landscape to be taken with an ordinary plate; the sky being blue, will throw on the plate the most efficient light, so as to produce on the negative the thickest dark layers. The leaves of the trees, on the other hand, will produce less intense effects, and still less will be the action of the red portions. Now the inventor, Oberleutnant von Slawik, an Austrian, has designed a special kind of pigment paper, bearing a number of superposed dye-stuff layers; underneath there is a red layer, in the middle a green, and above a blue layer. Now the most strongly covered portions of the negative—representing the sky—will evidently be the least translucent, the light actually penetrating being able to act only on the upper blue layer, rendering insoluble only the chromium jelly constituting this layer. The thinnest portion of the negative, corresponding for instance to a red wall, will in printing transmit the greatest amount of light; all three pigment layers thus being struck by the light will become insoluble down to the lowest red layer. The green leaves will, as above shown, give rise to a covering of the plate of medium intensity, a medium amount of light penetrating the paper at the corresponding portions of the plate, this amount of light being just sufficient to render insoluble the two upper blue and green strata, whereas the lowest layer will remain unaltered.

After printing, the paper, as usual, is pressed on another sheet of paper, when the coloured layers are transferred from one sheet to the other, the printing being afterwards "developed" with warm water, in the way usual in pigment printing

After the transferring the low layers of the original paper will in the new paper be uppermost. The warm water will, therefore, be able to rinse off any jelly layers which have not become insoluble by the effect of light. On the portions corresponding to the sky, the green and red layers which are not struck by light will be removed, the blue layer only remaining. In the red wall, where the light as above shown has penetrated all the existing layers down to the lowest red layer, which, after the transferring is above all the remaining, no alteration will be produced, while in the portions corresponding to the green leaves only the red layer, which now covers the green colour, will be washed off by the water, when the green colour becomes visible, covering the blue layer lying underneath. In practice, it has been found advisable to use a larger number of coloured layers instead of those corresponding to the three fundamental colours only, so as to produce all the shades required; up to 14 pigments are thus used. The above process has been developed in the laboratory of Dr. Ad. Hesekiel and Co., Berlin. As a matter of course, any old negatives taken at any time may be made to reproduce the true colours of the original.—A. G.

The Blondlot or N-Rays

In view of the interest which has been imparted to M. Blondlot's N-rays by the investigations of Professor Charpentier, and also by the doubts which have been thrown on the real existence of the rays, we have thought that it might be interesting to collect the ascertained facts and observations concerning these rays. For this summary we are chiefly indebted to a series of articles contributed by Mons. Laverune to *Cosmos*.

The N-rays were discovered by M. Blondlot, of Nancy, while studying Rontgen rays. By endeavouring to pass rays through a sheet of aluminium, he separated quite a new group of radiations. The rays he found were such as to penetrate aluminium, black paper, or wood. They could be polarised and might be deflected or diffused, but they produced neither fluorescence nor photographic action. They were invisible, gave no sensation of light, but augmented the brilliancy of an electric spark.

It is this property which enables us to detect the rays. They are incapable of exciting phosphorescence in bodies which can acquire this property from the action of light; but when such a body, sulphuret of calcium for instance, has first been rendered phosphorescent by exposure to light, then if submitted to the action of these rays, especially if they are focussed by a quartz lens, one can see the brightness of the phosphorescense perceptibly increase. In the same way if one directs them on to a little flame of gas at the end of a metal tube pierced by a very minute orifice this flame, entirely blue, becomes whiter and more luminous. We are now furnished with these means of detecting the presence of these radiations. M. Blondlot, struck with certain analogies that they present with the radiations discovered by Professor Rubens in the emissions of the Auer Burner, asked himself if the N-rays were not identical. An Auer burner was enclosed in a kind of lantern of sheet iron closed at all points, with the exception of the openings for the escape of air and the gas from combustion, and so arranged as to prevent the passage of any light. A rectangular window opened in the iron at the light of the incandescent mantle was closed by an aluminium sheet 1 mm. in thickness. The chimney of the Auer burner is of sheet-iron. A slit was opened opposite the mantle, so that the luminous rays which emanate from it might be directed on to the aluminium sheet. Outside the lantern in front of the aluminium sheet was placed a biconvex lens of quartz, and behind it an exciter giving little sparks. It was ascertained that the spark is of greater or less clearness according to the distance at which it is placed from the slit. M. Blondlot proved the existence of four distinct kinds of radiations. When one directs a pencil of these rays either on to an electric spark, or on to a little flame, or a phosphorescent substance previously exposed to light, one can see the light emitted by these different sources increase in brilliancy.

The greater number of artificial sources of light and heat emit N-rays. The sun emits them, as the following experiment shows: A completely dark and closed room has a window exposed to the sun, this window is shut by inside oak shutters, 15 millimetres in thickness. Behind one of these shutters, at a distance of 1 metre, is placed a tube of fine glass, containing a phosphorescent substance of sulphuret of calcium for example, previously slightly insulated. If now in the trajectory of the sun's rays, which are supposed to reach the tube through the wood, there is interposed a piece of lead, or even simply the hand, even at a considerable distance from the tube, the brightness of the phosphorescence diminishes. If one takes away the obstacle it re-appears. The interposition between the shutter and the tube of several sheets of aluminium, of cardboard, of a piece of oak three centimetres thick, does not prevent the phenomenon from taking place. All possibility of heat radiation, properly so called, is therefore excluded from hypothesis.

Certain substances appear to have the power of storing up N-rays, and afterwards emitting them; but the rays appear to penetrate a metallic mass, in this sense, very slowly. Thus, if one side of a sheet of lead two millimetres thick has been exposed to N-rays for some minutes, that side only has become active. An exposure of several hours is necessary for the activity to reach the other side. Aluminium wood, dry or moist paper, paraffin have not the property of storing up N-rays. Sulphuret of calcium has it. Having enclosed a dozen grammes of this sulphuret in an envelope, and then having exposed the envelope to N-rays, M. Blandlot proved that its neighbourhood sufficed to reinforce the phosphorescence of a little lamp of sulphuret previously exposed to light. This property explains why the increase of the phosphorescence of the action of N-rays takes an appreciable time both to be produced and to disappear. Owing, in fact, to the storing up of the N-rays, the different portions of a lump of sulphuret mutually augment their phosphorescence, the storing up is progressive, the store is not instantly exhausted, so that when one directs the N-rays on to the phosphorescent sulphuret their effect slowly increases, and when they are suppressed their effect is only gradually extinguished. Following on the experiments made by M. Charpentier on the emission of N-rays, experiments to which we shall return, M. Blondlot conceived the idea that certain bodies might acquire the property of emitting rays from compression. He proved that pieces of wood, of glass, of indiarubber compressed by means of a carpenter's vice, become, during the compression sources of N-rays.

Bodies which are themselves in a state of forced equilibrium, or molecular strain, as tempered steel or hammered brass, are spontaneous and permanent sources of N-rays. One can show it by means of the phosphorescent screen, and by another indirect method—that of the increased action of a pencil of light upon the eye when it is accompanied by N-rays.

The shutters of the laboratory are almost closed, and the face of the clock fixed to the wall sufficiently lighted for it to appear faintly as an indeterminate grey stain upon the wall at a distance of four yards. If the observer, without changing his place, directs towards his eyes the N-rays emitted by a brick or pebble, previously insulated, he sees the face whiten, distinguishes clearly its circular shape, and may even succeed in seeing the hands. When the N-rays are suppressed the face again darkens. Neither the production nor the cessation of the phenomenon are instantaneous.

As in these experiments the luminous object is placed very far from the source of the N-rays, and as besides, in order that the experiment should succeed, it is necessary that the rays should be directed not towards this object, but towards the eye, it follows that there is no question here of an increase of the emission from a luminous body under the influence of N-rays, but rather of the reinforcement of the action received by the eye, which is due to the N-rays which are joined to the rays of light. One can replace the brick by a sheet of tempered steel.

The energy that the emission of N-rays represents is probably borrowed from the potential energy which corresponds to the forced state of tempered steel. This expenditure is doubtless extremely feeble, since the effects of the N-rays themselves are so, and thus explains the apparently illimitable duration of the emission. A sheet of iron that is bent so as to take a permanent deformation emits N-rays, but

the emission ceases at the end of some minutes. A block of aluminium struck with a hammer does the same, but the duration of emission is much shorter. In these two cases the molecular constraint is temporary, and the emission of N-rays also. Torsion produces analogous results to compression.

Professor A. Charpentier's investigations of N-rays are second in importance only to those of their discoverer. He sought for the radiation of N-rays chiefly with the aid of phosphorescent screens of sulphuret of calcium, but found that screens coated with platino cyanide of barium, whose fluorescent intensity he regulated, with the aid of a salt of radium, covered with black paper, would give more satisfactory results. By these two processes of research, he discovered that N-rays can have several other origins than those of the sources of light indicated by M. Blondlot. He recognised that the little phosphorescent or fluorescent object increased in luminous intensity, when it was brought near the body. Moreover this augmentation is more considerable in the neighbourhood of a muscle, and so much the greater as the muscle is strongly contracted. The same thing occurs in the neighbourhood of a nerve, or of a nervous centre, where the effect increases with the degree of activity of the nerve or of the nerve centre. By this means, in spite of the delicacy of the observation, one can recognise the presence of a superficial nerve, and follow it. These effects are not only observed by contact with the skin, they are perceptible at a distance. They are transmitted through substances transparent to N-rays (aluminium, paper, glass, &c.), and stopped by the interposition of substances, which are opaque to the same rays, lead (incompletely) or wet paper. They are not due to an increase of temperature in the neighbourhood of the skin, for they continue if several sheets of aluminium are interposed, or of cardboard separated by layers of air and forming a calorific screen. These rays are reflected and refracted like N-rays.

M. Charpentier has produced foci, manifested by the maxima of brightening by the aid of convergent glass lenses. The position of these foci, or maxima, although difficult to exactly determine, permitted recognition of the fact that the indication of refraction of rays emitted by the body was at least of the class and size of that determined by M. Blondlot for N-rays. It might be asked if the human body really emitted these rays, or if it only stored them up during the day or in the light, in the same way as the insulated bodies studied by M. Blondlot. After a sojourn of nine hours in complete darkness the phenomena were the same, and were still more easy of observation, because of the more perfect adaptation of the eye. The nerves and nervous centres, when they are the seat of an excitation, emit the rays in greater abundance. Charpentier has been able to determine the area of the heart; he has also been able to follow the trajectory of a superficial nerve; he has been able to recognise the topography by certain psycho-motor zones in the cerebral surface. He has seen in fact, that if the subject of the experiment happens to speak, the detective screen, when advanced at the same moment towards the region of the cranium which corresponds to the zone of articulate language, at the level of the left frontal convolutions, is more brightly illumined than when he kept silence. The researches of Charpentier suggest that the radiations called N-rays are not all alike, but must in reality result from an assemblage of radiations of attributes as diverse as their origin some being emitted especially by the elements of the nervous tissues, and others by those of the muscular tissues. This theory is in accord with the physical observations of M. Blondlot. Experiments already dating from several months have in fact shown to this eminent physician that the bundles of N-rays broken up by a prism spread themselves into a sort of spectrum, which establishes beyond proof that all the broken rays—rays whose wave length, incomparably smaller than that of light rays—are unequally refrangible, and consequently possess each individual attributes. The wave length has been recently determined as not greater than 8 micro-millimetres—about the one millionth of a centimetre.

We have received from Mr. H. J. Glaisher a copy of his March catalogue of "remainders," which we notice contains many valuable and useful volumes in zoology, botany, and the various other branches of natural and applied science.

The Super-Solid.

Hints towards a Conception of the 4th Dimension.

By C. L. B[illegible].

Space, as we conceive it, comprises length, breadth, and thickness, and it is hardly possible to imagine a fourth direction which is none of these. Further than that, our minds are so constituted that we seem to see that such a new direction could not be. When we have traversed any material substance longitudinally, and across, and up and down we appear to have traversed it exhaustively. There is no direction which is not one of these, or, as we might say, there could be no direction which is not one of these three or intermediate between them. This is so as to all material substance, and that it is so as to space in the abstract we feel equally convinced, because by space we mean nothing else but the length, breadth, and thickness which matter occupies or might occupy.

Yet, as every appreciative reader of Abbott's Flatland knows, there is more to be said on this matter. Suppose a race of beings whose senses were such that they had never had any reason to suspect thickness as a property of matter, but were only conscious of length and breadth, would it not appear to them that length and breadth filled all space, and that a third dimension was as impossible as it was inconceivable?

Such a race of beings, conscious only of two dimensions, is indeed not unimaginable. Some have even theorised that a sightless snail, crawling from surface to surface, has no concept of any third dimension, but exception might be taken to the blind snail as an example of a Flatlander, for possibly his body might occasionally lap the two sides of a flat stone as he curled over the edge of it. But one can imagine a blind snail-like being of such minuteness that the smallest particles of all other matter were much larger than its body. Such a creature, though three-dimensional itself, might well have no suspicion of any dimension beyond infinite surface. It matters not in the least whether no such snail exists. The fact remains that such existence is imaginable, and that it is evident that in such a state of existence scepticism as to the possibility of a third dimension of matter would be just as deep and instinctive as ours is against the possibility of a fourth.

We may conclude, then, that our limiting of the number of dimensions possible to space to three, is due to the circumstance that as we are constituted our senses cannot conceive a fourth. To say that, therefore, a fourth does not or cannot exist is to go further than we have warrant for. But though we cannot see or by any sense perceive a fourth dimension in addition to length, breadth, and thickness, we may be able reasonably to infer something about the character of such a hypothetical dimension, assuming, for the sake of discussion, that it may exist.

Some of the properties of a fourth dimensional "super-solid" have been dealt with by more than one writer, notably by Spottiswoode, in his Presidential Address to the British Association at Dublin in 1878, and by Howard Hinton, in his interesting little volume on the subject of the Fourth Dimension.

A suggestion is often met with that Time is the fourth dimension of matter. Time may indeed be looked upon as a symbol of the fourth dimension, an illustration of the possibility of a direction which is neither up nor down, nor from side to side, for in time we there are for-

ward and backward directions which are neither of these and which are extraspatial? But, except in this figurative sense, the introduction of time as a solution of the fourth-dimensional question is merely a confusion of the problem. Time does not belong to the same category of thought with length, breadth, and thickness. Point, line, surface, solid these follow each other as a development in orderly sequence, but point, line, surface, solid, time—these terminate in a meaningless *non sequitur*.

Again, we may say that as a point is to a line so is a line to a surface, or we may say that as a line is to a surface so is a surface to a solid. This is intelligible, but to add, as a surface is to a solid, so is a solid to time, or to any portion of time, is unintelligible nonsense. Moreover, the concept of time does not strike one as being (as the conception of a sphere would be) impossible to Abbott's Flatlanders, whereas it ought to seem even more so if it were actually two dimensions ahead of them. Indeed, it ought to seem impossible to ourselves, unless we are fourth dimensional beings.

But without confusing the issue by incongruously introducing the concept of Time into the province of Space, let us see what may reasonably be conjectured as to fourth-dimensional existence.

The elements of the inquiry are strikingly illustrated by Hinton in some such way as the following:-

Two points joined = One line.
Two lines joined = One square.
Two squares joined = One cube.
Two cubes joined = One (?).

The series may be set out in this way:—

		No of Dimensions	Terminal Points	Joining Lines.
Point	.	0	1	0
Line	—	1	2	1
Square	□	2	4	2
Cube		3	8	4
Super-cube	?	4	16	8

Before we proceed to deal with the perspective representation of the last in this series of figures, the super-cube, it will be well to put ourselves back in imagination into Abbott's Flatland, and to consider what would be our Flatlander's impression of the perspective representation of the cube. "Here is no third dimension," he would say; "here are but two squares with lines joining them." To us, who are accustomed mentally to connect such a figure with the similar retinal image which a solid cube forms in our eye, the concept of a third dimension is conveyed by association of ideas, but with the Flatlander no such association of ideas would exist, because he would have had no experience of "thickness," and the figure would remain for him a Flatland one two squares joined by four lines. Similarly, a full-face view of a cube would of course be to him simply a square, and in fact cannot be otherwise rendered on a flat surface.

Now our relations to fourth dimensional diagrams must be analogous. It is possible that we might make a pictorial rendering of a super-cube on paper, which to a being with senses capable of appreciating fourth-dimensional space would be suggestive of a fourth-dimensional super-solid, but to us, with no association of ideas to aid us, the figure must not be expected to afford a representation of more than three-dimensional form. The figure for the super-cube would, in fact, be like this:—

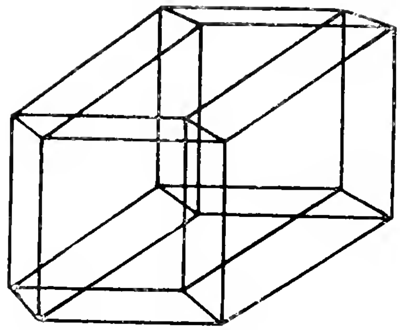


Fig. 1.

As the drawing of a cube to a Flatlander would seem to be only two squares on the same surface united by lines also on that surface, so to us the above figure can at most only convey the idea of two cubes united by lines or perhaps by surfaces. We shall see this better if we draw the figure in perspective stereoscopically and examine the result in the stereoscope, when the two drawings will blend into one apparent solid. Here is such a stereoscopic diagram of the super-cube:—

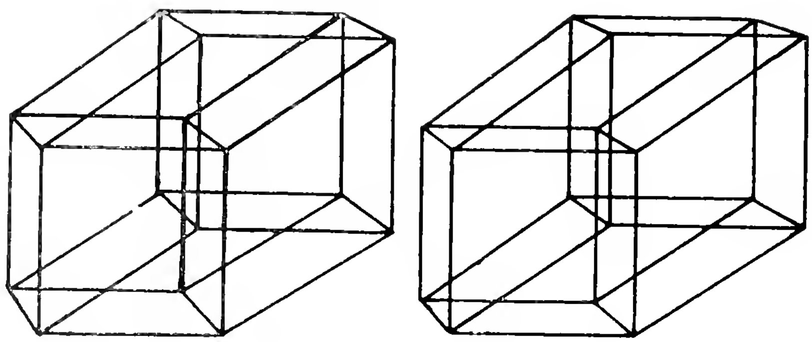


Fig. 2.

This slide, when seen in the stereoscope, shows us a peculiar looking figure, apparently three-dimensional. Now just as the perspective drawing of the cube suggests one three-dimensional figure to us but to the Flatlander a pair of united squares, so the above stereogram represents a pair of united solids to us, but to beings with fourth-dimensional perception it might convey the notion of one super solid.

It becomes evident, therefore, that while our senses are (as at present) limited to three dimensions, we cannot expect in the way thus far indicated to get any nearer to a concept of the super-cube.

Yet there remains an experiment which carries us just a step further, and brings us to the very verge of a solution of our problem.

Before we make this experiment it will again elucidate the matter if once more we imagine ourselves for the moment in Flatland. There the drawing of a cube directly facing us would, as we have seen, be only one square, or more strictly one square exactly behind another. To the Flatlander, who does not know what "behind" means, it would be as though the two squares occupied the same space at the same time.

Now the analogy from this is obvious, for in the same way under similar circumstances the super-cube of fourth-

dimensional perception would to our perception seem like two cubes occupying the same space at the same time. They would really represent two separated cubes, but separated in a direction neither up nor down, nor sideways, nor cross ways—in a direction of which we, with our three-dimensional conceptions, have no cognizance, just as the Flatlander had no cognizance of the meaning of a square being "behind" another square. The perspective view of the cube when not seen full face would show the Flatlander the two squares only partially occupying the same space at the same time. In like manner we may put it that the super-cube, if presented to us broadside, would look like two cubes occupying the same space at the same time, while in other positions the two cubes would only partially occupy the same part of space.

Now of this we can get some sort of representation by an interesting experiment with the stereoscope. Just as two flat drawings will give a representation of solidity when appropriately drawn and placed in that instrument, so two solids viewed through it will give some sort of idea of the super-solid.

The experiment is striking and remarkable. Place in the centre of the field on each side in a stereoscope a solid cube. On looking through the instrument the two combine, and one cube is apparently seen. Now while looking at this one cube move slightly either of the cubes as it lies in the stereoscope, and it will be seen that our apparent one cube was composed of two occupying the same space at the same time. With the movement of one cube it is seen to pass partly out of the other, and we have an impression as to our super-solid exactly the counterpart of the Flatlander's impression of the cube as shown to him in the perspective drawing, first full face (the two squares occupying the same space and appearing as one) and then a more side view in which the two squares only partially occupy the same space.

Using a cube on one side in the stereoscope and a ball of approximately the same size on the other the effect is still better seen, and without moving either the strange spectacle is revealed of a sphere and a cube occupying together the same part of space.

The experiment affords, of course, but a suggestion of the fourth dimension, yet taken for what it is worth that suggestion is pregnant and of no small interest.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Microscopical Material.

By the kindness of Mr. W. S. Rogers, of Upper Warlingham, I was able last month to offer to the microscopical readers of "KNOWLEDGE AND SCIENTIFIC NEWS" some "Comfrey" leaves (*Symphytum officinale*), which show well the beautiful bases of the leaf hairs. Mr. Rogers states that the appearance referred to is not seen in the leaves when fresh or when dried under pressure, but would seem to be brought into prominence by the blackening of the leaves when they lie fermenting on the ground in autumn. He adds that the material is intractable to handle, the dried leaf being brittle and inclined to curl, and he has therefore punched them into $\frac{3}{4}$ inch circles. They should, of course, be mounted as opaque objects. I regret that by a printer's oversight this notice was omitted last month, whilst the coupon was omitted the month before, thus causing unnecessary trouble to my many correspondents.

Preserving Specimens of Orthoptera.

A recent number of the American *Journal of Applied Microscopy* contains some interesting suggestions for preserving specimens of Orthoptera. As the writer says, their comparatively large size, juicy bodies, when alive or just killed, brittleness of limbs and antennæ when dried, their proneness to fading after death, and their liability to the attacks of mould and museum pests, all seem to conspire against their preservation. The larger and more showy specimens are best known, and the smaller and less brightly coloured forms are either entirely unknown or have come to the notice of the very few specialists who have ventured into an almost forsaken field. There is, therefore, a rich field for investigation for any microscopist who is in want of a fitting direction for his studies.

Placing these insects in alcohol and other liquid preservatives has, in fact, overcome the objection to the soft juicy bodies that so quickly shrivel and become discoloured when treated by the ordinary means of preserving insects; but it has the disadvantage of quickly effacing the many bright colours common to such large numbers of them, and even changes minute structural characteristics, so as to render the insects difficult of recognition. It also adds greatly to the space taken up by the collection, and renders their transportation difficult. Still it is an effective preservative against insect pests, such as *Dermestes*, &c. Orthoptera can, however, be handled "taxidermically"—*i.e.*, stuffed much as birds, &c., are stuffed. Instead of throwing the insects into spirits, they should, when captured, be killed in the cyanide bottle. The specimen being then held in the fingers and thumb of the left hand, with a fine, sharp-pointed pair of scissors open the abdomen by cutting across the middle of the two basal segments on the lower side, then reverse and cut the opening a trifle larger by nearly severing the third segment. Then extract all the insides (intestines, crop, ovaries, &c.), along with the juices, using fine forceps for this purpose, and wipe out the inside with a small wad of cotton. This being done, the insect may be pinned into a box or wrapped in paper and packed away for future use.

The "stuffing" is carried out as follows. Cut some raw cotton into short pieces, and fill up the insect through the opening made as above, using similar fine forceps and taking care not to stretch or distend the abdomen beyond its original dimensions. When the filling is completed draw the edges of the severed segments carefully together, and press the sides of the abdomen into shape with the fingers. This can all be done, after a little practice, in four or five minutes' time. It will be found that the insect will not decay or turn dark, the original colours will be almost entirely preserved, and there is but little danger of attack by museum pests, or of the mould which so frequently spoils objects which are long in drying.

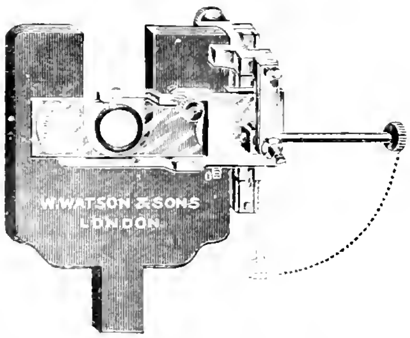
Mouldy specimens can often be saved by being placed in a tin box between wet cloths or blotting papers well sprinkled with dilute carbolic acid, and left for twenty-four hours to thirty-six hours, or until sufficiently soft not to break when handled. Then pour some alcohol into a dish, and add to it about one-twentieth as much liquid carbolic acid. With a camel-hair brush carefully clean the entire insect, taking care to wash every portion with the mixture of alcohol and acid.

In arranging in the cabinet the suggestion is made that much space can be economised by directing long antennæ backwards along the sides of the insect, and by folding and crossing the legs beneath the body. In the Saltatoria, or jumping forms, the pin should be inserted near the back edge of the pronotum, a little to one side of the middle, and directing it to the rear, letting it pass downward through the mesothorax, thereby tightly fastening together the two sections of the body. In the other forms, *Blattoidea*, *Mantoidea*, and *Phasmoidea*, the pin should be inserted behind the pronotum through the middle of the body, taking care to select a solid portion for this purpose, without running the pin through the basal portion of any of the legs.

The "Argus" Attachable Mechanical Stage.

This stage was designed for use with the "Argus" microscope, noticed in the January issue of "KNOWLEDGE," page 21, but it can be fitted to any ordinary microscope, being attached

by means of a thumb screw only. It is decidedly original in design. A friction wheel, actuated by a single milled head, is in contact with a broad brass plate attached to the clips which hold the slide. A steel spring gives the necessary pressure, and the spindle bearing the friction wheel and milled head is movable on a vertical pin. A glance at the illustration will make the principle clear, and it will be seen that the stage



travels readily in a vertical or horizontal direction, or in any intermediate diagonal direction, according to the position in which the milled head is held whilst rotating. Check pins indicate the horizontal and vertical positions respectively. By this means not only are rectangular movements obtained, but any desired diagonal movement is obtained in addition. The whole stage works with great smoothness and sensitiveness. The mechanism is entirely on one side of the stage, so that none of the working parts are in the way of the instrument.

Quekett Microscopical Club.

The 409th ordinary meeting of the Club was held on December 18, at 20, Hanover Square, W., the Vice-President, A. D. Michael, Esq., F.L.S., in the chair. A most interesting collection of diffraction gratings of various kinds was on view, and the exhibitor, Mr. Julius Rheinberg, F.R.M.S., briefly described them and pointed out the curious optical effects obtainable. Among the most interesting of the exhibits was a reflecting diffraction grating on plate glass, silvered on the grating side, ruled by Colonel L. Paxton, of Chichester. It consisted of intersecting systems of circles. Each system consisted of a series of excentric circles, the locus of their centres being an intermediate circle. When exposed horizontally below a flame, an observer stationed a few yards away could see four intersecting rings of light stereoscopically projected several inches in front of the mirror, whilst a similar system of rings was seen several inches behind the mirror.

Mr. Rheinberg then read a paper "On an Overlooked Point concerning the Resolving Power of the Microscope." It dealt with a discovery made from the theoretical standpoint some years ago by Dr. Johnstone Stoney, F.R.S., which had only recently been practically demonstrated—viz., that an objective would resolve and separate two dots or lines of a known distance apart, although unable, owing to its N.A., to resolve a series or band of dots or lines at equal similar intervals. The experiment was practically demonstrated to the Club, a Grayson test plate of 15,000 lines to the inch being used for the purpose, with a Zeiss 8 mm. apochromat. and a 27 mm. compensating ocular.

Mr. D. J. Scourfield, F.R.M.S., then gave an epitome of the third part of his Synopsis of the British Fresh Water Entomostraca. It dealt with the Ostracoda, of which we have about [illegible] species, nearly all widely distributed; the Phyllopoda, of which there is only a single form now recorded, another form, [illegible] being apparently extinct; and the Branchiura, with two species, one being extremely rare. This was the concluding portion of Mr. Scourfield's valuable series of papers on the British Entomostraca.

The 410th ordinary meeting of the Club was held on January 15, the President, Mr. George Massie, F.L.S., in the chair. There was a large attendance. Mr. C. Rousselet, F.R.M.S., read a paper on "A New Freshwater Polyzoon from Rhodesia," which was illustrated both by a diagram and by specimens shown under the microscope. The polyzoon referred to differs in many ways from all other known species, and is especially characterised by the production of elliptical statoblasts having five spines at each end, the spines being armed with minute hooks.

Mr. J. T. Holder exhibited an interesting series of lantern slides of Foraminifera from photographs taken by himself. The specimens varied much in size, some of the large groups being $\frac{1}{4}$ inch in diameter, and containing several hundred selected specimens from $\frac{1}{100}$ to $\frac{1}{8}$ inch in diameter. A 4-inch objective was used, and in spite of the difference in focal plane the photograph was quite successful. Other photographs were taken with 2-inch and 1-inch objectives. The exposures varied from a few seconds to three quarters of an hour, an isochromatic screen being invariably used. The camera and apparatus employed were also shown on the screen.

Mr. Earland gave a brief description of the slides, and congratulated Mr. Holder on his success, and especially on the way in which the glassy transparency, which was one of the most beautiful features of the hyaline Foraminifera, had been reproduced in the photographs. Attention was particularly drawn to *Frondicularia alata* from Cuba, found at the depth of 700 fathoms. The genus was now almost extinct, but was abundant in Secondary times. At present it was found in numbers in only two small areas in the world, each widely distant from the other, namely, the Caribbean Sea and the shores of New Guinea. Attention was also called to the great difference in the form and structure of the specimens shown on the screen. This was due to the different methods of growth, which, in turn, was a result of the difference in size of the primordial chambers. It was a typical instance of dimorphism, and the two specimens represented the megalospheric and microspheric types respectively. Two especially interesting slides were *Polystomella craticulata* and *Orbulina universa*. In the first the foraminifer was shown side by side with a cast of the animal's body, the cast being quite perfect, and exhibiting every detail of structure, the canal system and primordial chamber being sharply marked on the screen. In the slide of *Orbulina universa* some of the spherical details had been laid open in order to show the internal Globigerina shell. This was shown in various stages, from the perfect shell, attached by five spines to the inner surface of the sphere, and not distinguishable from a pelagic Globigerina, to the last disappearing chamberlet. The mystery of these internal chambers, which were only found in a small percentage of specimens, was unsolved; but a theory had been invented to account for them. It was supposed that the pelagic Globigerina, in order to protect its delicate spinous shell from the action of the waves, formed a spherical shell outside it, and the internal shell being then of no further use was gradually absorbed and disappeared. A number of photographs of rock-sections next exhibited showed Foraminifera *in situ*, and exemplified the important part played by them in the structure of the earth, more important than all other animals put together. They were amongst the very earliest inhabitants of the earth, their remains being found as far back as the Lower Cambrian strata, and some of the genera, perhaps even species, found there were still in existence. They formed enormous masses of limestone in carboniferous times, and the gault and chalk were largely composed of their remains. But they reached their greatest development in Tertiary times, when the famous Nummulitic and Alveolina limestones were built up by them, the deposits stretching in an almost unbroken series across Europe and the western half of Asia, reaching a thickness in places of many thousand feet. Their modern representatives were both small and infrequent.

In addition, a number of marine organisms, admirably preserved, were shown under microscopes on behalf of Mr. H. J. Waddington, a former member of the Club.

ROYAL MICROSCOPICAL SOCIETY. December 16, Dr. Henry Woodward, F.R.S., President, in the chair. Mr. F. W. Watson Baker exhibited under microscopes an exceedingly complete and valuable series of slides, 16 in number, illustrating the development of an ascidian from the fertilization of the ovum to the larval stage. The slides were prepared by a gentleman well known to many of the Fellows, who had been most successful in his management of marine aquaria. Dr. G. J. Hinde read a paper "On the Structure and Affinities of the Genus *Porosphaera*," which was illustrated by diagrams, mounted slides under microscopes, and specimens, many collected by Dr. Hinde in his garden at Croydon, which had

been weathered out of the chalk. January 20. Annual Meeting the President, Dr. Henry Woodward, F.R.S., in the chair. The Curator, Mr. C. Rousselet, exhibited an old microscope by Plossl, of Vienna, which had been sent on approval. It has a folding tripod foot which carries a short column surmounted by a compass joint for inclining the instrument. To a hinged attachment of the compass joint a triangular steel bar is fixed. On this bar slides a bracket, having a curved arm, to which the body of the microscope is secured. A rack is sunk into the base or back of the triangular bar for the coarse adjustment, the pinion of which is contained in the sliding bracket. The stage, which is also carried by the triangular bar, has slow rectangular movements of very limited extent. There is also a micrometer movement, right and left, for measuring objects, and a fine adjustment for focussing. There are six object glasses which can be used separately or in various combinations of two or three glasses. Among the apparatus is a lenticular prism for illuminating opaque objects and two diaphragms for reducing the diameter of the reflecting surface of the mirror. The ballot for officers and Council for the ensuing year was then taken, and Dr. Dukinfield H. Scott, F.R.S., was elected President. The other business of the annual meeting having been disposed of, Dr. Henry Woodward, the retiring President, proceeded to give his annual address, taking as his subject "The Evolution of Vertebrate Animals in Time." His paper was illustrated by diagrams, drawings, and slides, about 80 in number, shown upon the screen.

A Novel Electric Traction System.

In No. 2 of the *Elektrotechnischer Anzeiger* E. Lenggenhager describes an electric railway traction system which is being developed at the present moment by a Swiss "Studiengesellschaft," appointed for the purpose of finding out an electric railway system suitable for that country, which, on account of her dependency on the foreign coal market, evidently should endeavour to utilize her wealth in hydraulic power. Speeds, on the other hand, are limited there on account of the steep gradients, small curves, and numerous stoppages. The system in question uses *steam locomotives heated by electricity*. Electric heating, as is well known, will work with the highest possible efficiency, so that the total efficiency will mainly depend on the output of the mechanical part of the locomotive, being the steam-engine proper. Any coal steam locomotive could readily be converted into an "electrothermical" locomotive by simply replacing the fire-box and boiling-tube of the boiler by a number of parallel electric heating-walls running throughout the boiler and being composed of two copper or iron sheets. The author suggests using in this connection the well-known Prometheus heating elements. The consumption of current would depend on the consumption of steam. Let the boiler be designed for accommodating 4000 litres of water, which are to be brought within 3 hours from 10 up to about 190° C., corresponding with a steam pressure of 50 kg. per sq. cm. In the case of an efficiency only as high as 90 per cent. the following data would be obtained: 4000 l. of water would require, in order to be brought to the above temperature, $4000 \times 180 = 720.000$ kg. cal.; 1 kg. cal. = 1·275 eff. watt. hours, therefore 720.000 kg. cal. = about 900 eff. kw. hours, or, distributing this amount over 3 hours = about 300 kw. A consumption of steam of 1000 kg. per hour would accordingly require a supply of current of about 225 kw. As regards the advantages inherent in the electrothermic system, the resistance of the steam accumulator against current shocks should be mentioned. There is the further advantage of both direct and alternating currents being practicable in this connection, any desired combination being suitable. The mean efficiency of electrothermic locomotives, being about the same as that of an electromotive machine of the same size, would be about 60 to 70 per cent., whereas the total efficiency of a railway system, on account of the more advantageous utilization of the load, would be higher for the former. Furthermore, the adoption of electrothermic service may take place gradually, being much easier than that of electromotive service, on account of the lower cost of the conversion and the easiness with which the *personnel* may be trained for the new service. A possible conversion of electrothermic into electromotive railway service would finally be readily made should the electromotive service in future be so improved as to become superior to the electrothermic system.—A.G.

Geodetical Instruments.

From Mr James Hicks, of Hatton Garden, we have received a catalogue of the new types of hand surveying instruments designed and patented by Sir Howard Grubb, F.R.S. These extremely ingenious and useful instruments were designed by the inventor primarily for the use of those whose work in surveying required simple, portable, and easily comprehensible instruments for rapid work. The principal advantages common to all the instruments are the film surface of the glass, which is of a kind capable both of reflecting and transmitting a considerable portion of the light which falls on it, and the adoption of the collimator system for parallelising rays. By the use of the Reynolds Grubb film, light from two different directions can be directed into the eye of the observer without recourse to the inconvenient old method which was known as "dividing the pupil." The collimator system of parallelising rays has also great advantages in convenience and simplicity of observation. Among the instruments to which these methods have been specially and advantageously applied are the small clinometer and prismatic compass and a level. Mr. Hicks also comprises in his catalogue of these new types of hand surveying instruments, an optical square fitted for use with the naked eye, an attachment for a telescope, a graphometer, and a pocket surveying instrument.

REVIEWS OF BOOKS.

Who's Who, 7s. 6d. (A. & C. Black), grows stouter every year, and now contains no fewer than 17,000 biographies. Its great usefulness is so well recognised that it need not be dilated upon. Some few of the biographies might, one would think, be curtailed, especially as regards "recreations," one of which, we note, reads "homely table games of cards, chess, backgammon, halma, cribbage, &c." Otherwise, the succinct accounts of the lives of every Englishman of any note are most complete, and just what one requires.

Who's Who Year Book, 1s., is a small book containing the tables which were formerly incorporated in *Who's Who*, but which have been deleted from time to time to make room for the ever-increasing number of biographies. These tables are most useful for reference, including as they do not only such as are to be found in many other annuals, but also lists of Royal Academicians, Bishops, Newspapers and Magazines, Pseudonyms and Pennames, Principal Schools (with number of pupils and cost), Fellows of the Royal Society, Societies, &c., Chairs and Professorships, Heirs of Peers, &c.

The Englishwoman's Year Book, 2s. 6d. (A. & C. Black), "aims at giving some idea of the extent of women's work and interests, and some guidance to those who want to help their fellow-creatures, whether as individuals they live lives of which their own home is the centre, or take a wider view of their opportunities and responsibilities," and has a wonderful mass of useful information packed into its 350 pages.

BOOKS RECEIVED.

(The notice of books in this column does not preclude the review of them at a later date).

Studies in Heterogenesis, by H. Charlton Bastian, M.A., M.D.Lond., F.R.S. (Williams and Norgate, one vol.; price 31s. 6d.) A monumental work, illustrated with more than eight hundred micro-photographs, and summing up the whole number of instances of the apparent transformation of the substances of parent matrices into new forms of life. The author examines the alternative explanations of these phenomena—(1) That the resulting forms of life are due to the invasion and multiplication of parasites within what appear to be parent organisms; (2) that the resulting forms of life are in reality heterogenetic products originating from the very substance of the organisms from which they proceed—and gives his reasons for adopting, after prolonged and careful study, the second of these theorems.

The Worship of the Dead, by Colonel J. Garnier. (Chapman and Hall, one vol.). Colonel J. Garnier's work on "The Worship of the Dead" (Chapman and Hall) deals with the origin and nature of Pagan idolatry and its bearing upon the early history of Egypt and Babylonia. The voluminous materials collected by previous writers on the subject are here set forth within a moderate compass and in a readable form. The book is profusely illustrated with interesting examples of the statues of ancient gods.

Cassell's Popular Science (Cassell and Co.), edited by Alexander S. Galt, with contributions from T. C. Hepworth, Professor Bonney, Frank Weedon, John Fraser, F.L.S., Wilfred Mark Webb, F.L.S., Dr. Andrew Wilson, Dr. Bernard Hollander, and William Ackroyd, F.I.C. The subjects range from radium to carnivorous plants, and from the transit of Venus of 1882 to the working dynamo. The articles, of which there are some sixty, are clearly and well written, and in every respect justify the title under which they are collected.

British Tyroglyphidæ, by Albert D. Michael, F.L.S., F.S.S., &c. Vol. II. (Printed for the Royal Society.) This volume contains the description, with plates, of the genera and species of the British Tyroglyphidæ, from the genus Chortoglyphus to the Tyroglyphus Wasmanni. A list of foreign species is added.

The Old Testament and Historical Records, by Theophilus Pinches, LL.D. (One vol. Second Edition. S.P.C.K.) In the second edition of the "Old Testament in the Light of the Historical Records and Legends of Assyria and Babylonia," Dr. Pinches adds some exceedingly valuable and interesting matter on the Laws of Hammurak, together with a translation of the laws and notes on Delitzch's lectures on this subject.

A School Geometry. Parts I.-V. By H. S. Hall, M.A., and F. H. Stevens, M.A. (Macmillan. One vol.; price 4s. 6d.)—This is a publication, in one volume, of a geometry for schools based on the recommendation of the Mathematical Association and on the new Cambridge syllabus.

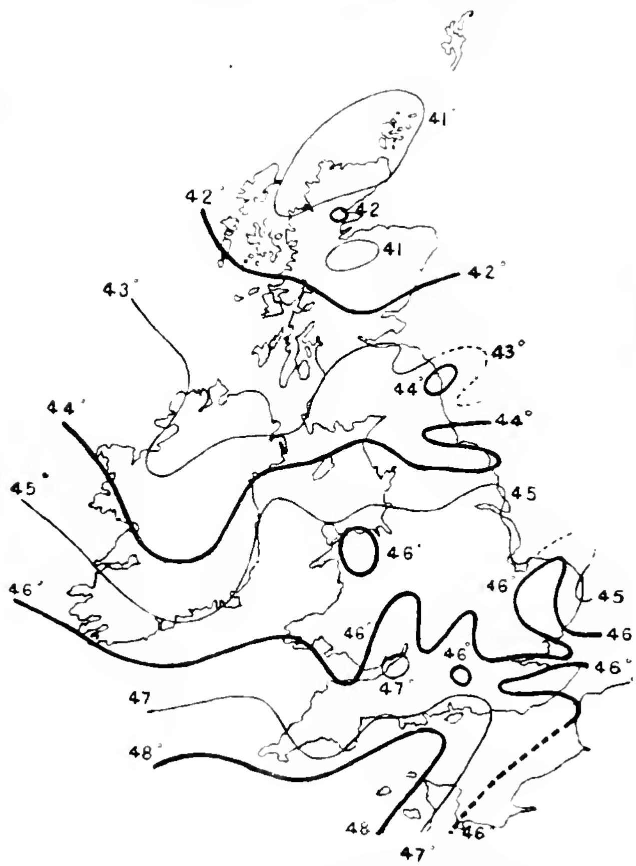
Descriptive Chemistry, by Lyman C. Newell, Ph.D. One vol., with supplementary vol. of experiments. (London: D. C. Heath; price 4s. 6d. and 1s. 6d.)—Intended for teachers who wish to emphasise the facts, laws, theories, and applications of chemistry. The experiments have been prepared for limited laboratory facilities.

Chess Problems.

Owing to the great amount of matter which we have on hand we have felt it necessary to again postpone publishing the Chess Problems. We should be very glad to have the opinions of those interested in this subject as to the continuance or otherwise of the Chess Column.

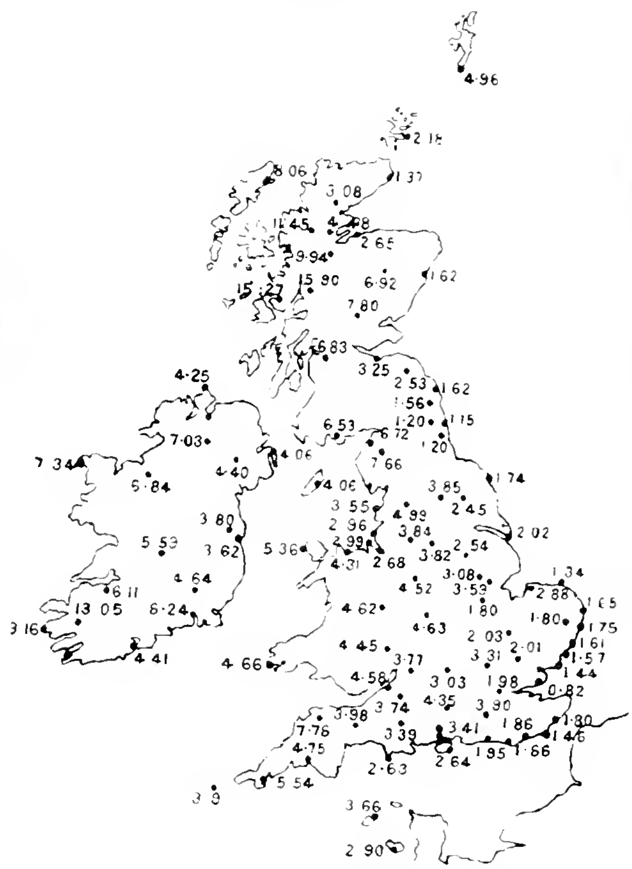
LAST YEAR'S WEATHER—MARCH, 1903.

DISTRIBUTION OF MEAN TEMPERATURE.



The general distribution all over our islands agreed very fairly with the normal, but the actual values were above the average in all localities excepting the west and north of Ireland.

RAINFALL.



Rainfall was considerably in excess of the average over the country generally, but was rather deficient on the east coasts of England and the north-east coasts of Scotland. Over the western half of the Kingdom the excess was very large, the amount at many stations being more than double the average.

Knowledge & Scientific News

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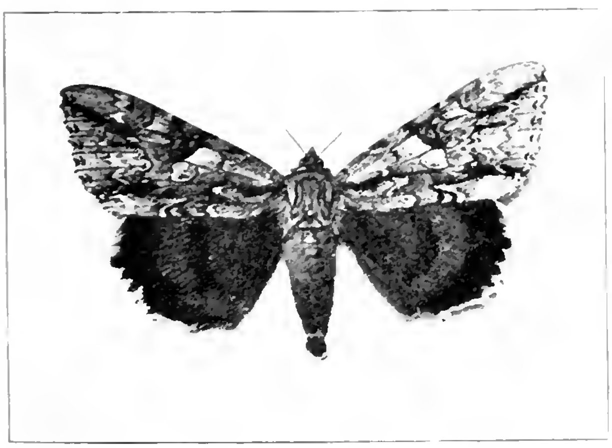
Contents and Notices.—See Page VII.

The Protective Resemblance of Insects.

By Percy Collins.

The story of insect life has many phases of entrancing interest: nor is this altogether surprising when we remember that the earth, the air, and the water are alike peopled by the vast army of the six-footed. These varied conditions of life have left their mark not only upon the habits and movements of insects, but upon their colour, their form, and their instinctive attitudes of repose. So that although insects are more diverse than any other natural group of living creatures, the explanation is simple; they are and have been subjected to almost every condition under which life is known to be possible. Thus, to the entomologist, every difference of form, colour, or attitude seems worthy of serious investigation. He realises that an unusual tint or a quaint pattern carries with it a definite meaning—that it is in some way linked to the ancestral history of its possessor. Often enough this meaning is mysterious. But occasionally the colours and form of an insect, or of a group of insects, can be explained as the direct outcome of certain known influences. Not infrequently such interpretations reveal the fact that the shape or colour of an insect, or both in combination, are mainly responsible for its well being. The creature's peculiar appearance either mystifies its enemies or enables it to approach unobserved the smaller insects upon which it preys. The whole subject, to which the general term "mimicry" is commonly applied, constitutes one of the most fascinating phases of entomological study.



Catocala sp. Japan.

The simple protective resemblance of an insect may be either general or special. That is to say, the protection may originate in the mere likeness of an insect's surface colouring to that of its customary surroundings, or it may consist in an actual reproduction in both form and colour of a certain object with which the creature is commonly associated throughout its life.

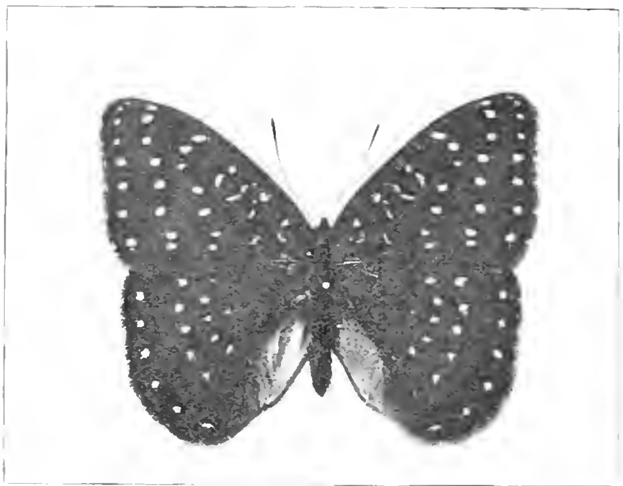
Instances of general protective resemblance must be familiar to observers in all countries. The numerous moths which are accustomed to rest for hours together upon rocks or tree trunks are oft-cited examples. Conspicuous among them is the whole genus *Catocala*, the various species of which are widely distributed in the Palaearctic region and elsewhere. These moths have brightly coloured hind wings, the usual tint—which has given to them their popular title of "Red-underwings"—being some shade of crimson or pink. When they are on the wing they are sufficiently conspicuous, and are liable to be snapped up by a hungry bird. But when at rest upon a tree trunk in their customary attitude of repose, the soft grey or brown colour of their fore wings produces a general effect so well in keeping with the

Catocala sp. Japan. At rest on bark.

rough surface of the bark, that they are extremely difficult to detect. Their colour pattern alone constitutes a most effectual hiding.

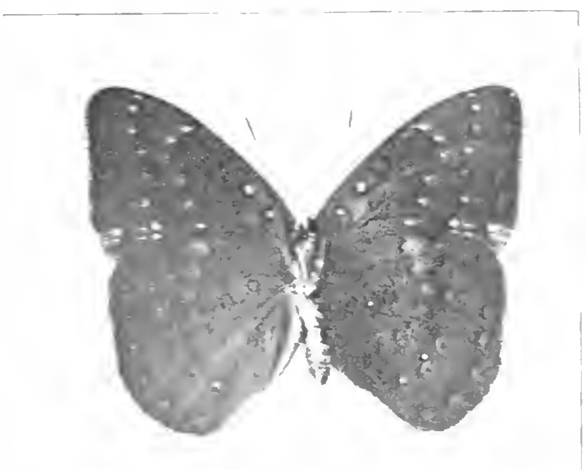
The same may be said of countless other moths, especially of the great *Noctua* group; and it is interesting to trace how closely the colour of the fore wings in a given species corresponds to its habitual resting place. The appearance of all kinds of bark, of mossy twigs and of lichen-covered rocks is faithfully reproduced; nor is it necessary to search beyond the moths of our own islands for striking examples.

Many butterflies, especially of the great group *Nymphalinæ*, possess—in the tints of their under side—a general resemblance to the ground upon which they habitually



Hamanumida dedalus. Africa.

settle. Moreover, many species seem to have acquired the trick of inclining their folded wings out of the perpendicular, by this means covering, or minimising, their own shadow, as well as bringing the protectively coloured underside into more prominent view. This habit may be observed in many of our common "brown" butterflies—for instance, in *Pyrarga megaera* and in *Satyrus semele*. In connection with this apparently acquired aid to protected resemblance, the habits of *Hamanumida dedalus*, an African butterfly, are exceedingly interesting. It is authoritatively stated that this insect rests in West Africa with its wings folded over its back after the



Hamanumida dedalus. (Underside.) Africa.

common habit of butterflies, in which position its tawny under surface, which agrees with the general tone of the soil, is exposed to view. In South Africa, on the other hand, the same insect sits with its wings expanded, showing the brownish grey upper side which harmonises with the colours of the rocks in that region.

Many of the *Coleoptera*, from their colour, are almost indistinguishable when resting upon lichen-incrusted bark. The accompanying photograph of a *Longicorn* from Bhutan admirably illustrates this phase of general protective resemblance. Although the insects are in full view, the casual glance quite fails to detect their presence. This surprising result is largely gained by the manner in which the colour is, as it were, cut up into dark and light patches. This is particularly noticeable in the long antennæ, the sharp outline of which is entirely effaced from their being coloured in alternate lengths of black and grey.

Turning from general to special protective resemblance, we find a number of extremely interesting and remarkable examples, especially among exotic insects. The butterflies of the genus *Kallima*—"leaf butterflies," as they are popularly called—bear striking testimony to the

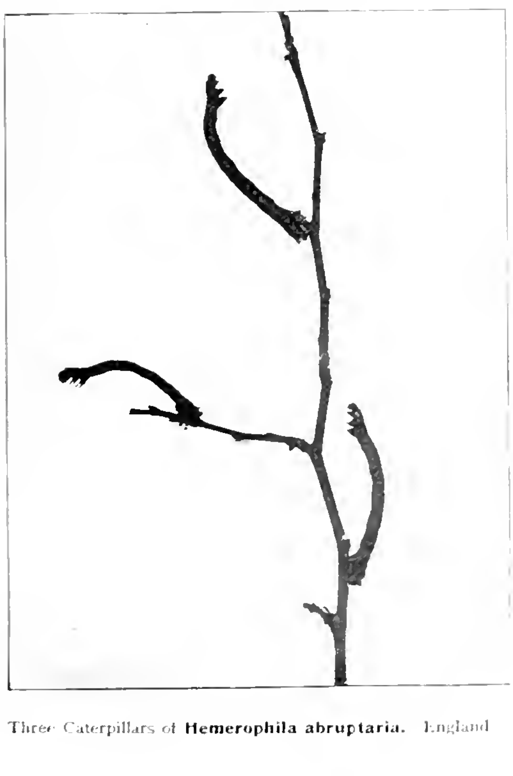
Apalimna ducalis. Male and Female. Bhutan. On Lichenous Bark.

powers of natural selection. When flying in the full sunlight, their wings flash with colour, but directly they come to rest upon a twig they are, to all appearances, brown and withered leaves. This sudden transformation is made possible by the tinting of the under surface of the wings, and by the curiously erect attitude which the insect is able to assume—its wings drawn upright over the back and its head and antennæ concealed between their anterior margins. When we consider the marvellous accuracy of the colour imitation, the uncommon shape of the insect's wings and its unusual pose, the leaf butterfly must still be ranked as one of the most amazing instances of protective resemblance yet recorded, notwithstanding the many marvels which have been brought to our notice within recent years.

The larvæ of moths grouped under the title *Geometridæ* usually bear a curiously accurate resemblance to little twigs or sticks, both in shape and in their brown

Kallima niachis. India. Two Specimens at rest among leaves.

or grey colouring. Moreover, this deception is materially heightened by the unique attitude of repose obtaining among these caterpillars, which differ from most lepidopterous larvæ in possessing only two instead of five pairs of pro-legs. These are placed at the extreme posterior



Three Caterpillars of **Hemerophila abruptaria.** England.

end of the body, while the three pairs of true legs at the other extremity are usually exceedingly diminutive. The perfect stick likeness is gained in the following manner. The caterpillars of the *Geometridæ* usually feed at night. When daylight comes, or under the stimulus of alarm, they take a firm hold upon the twig with their four pro-legs and stretch out their cylindrical body stiff and straight at an acute angle. In this position they are capable of remaining, absolutely motionless, for hours together. But to counteract the terrible strain which the attitude would impose upon the body of the caterpillar, each usually spins a strong, though practically invisible silken thread from its mouth to the twig on which it rests.

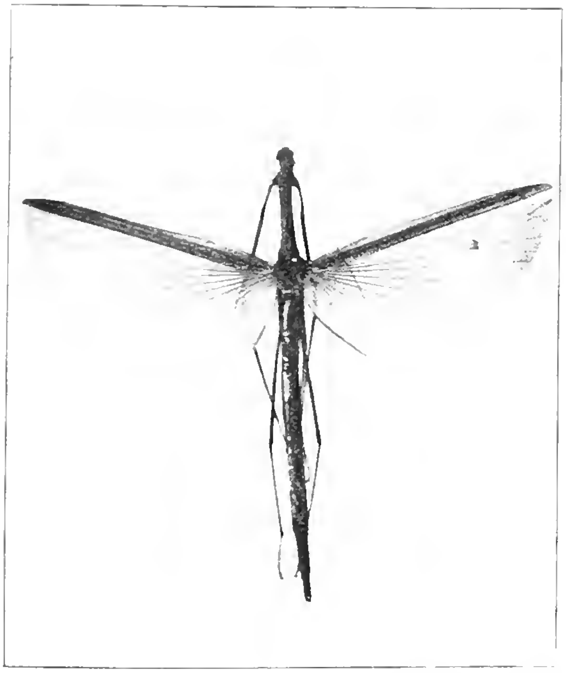
A family of insects remarkable above all others for the almost universal protective resemblance of its members is the *Phasmidæ*. In order to understand these creatures, which are numerous in all tropical countries, it is necessary to know something of their habits. Unlike their

Clitumnus Sundaicus. Stick-like Phasmid.

near relatives, the *Mantidæ* or "praying insects," which are voracious insect eaters, the *Phasmidæ* are exclusive vegetarians, feeding greedily upon the leaves of the plants which form their resting places. In movement, Phasmids are extremely sluggish, and many of the species—being apterous or possessing, at most, only rudimentary wings—are incapable of flight. Thus, they are much exposed to the attacks of birds and other insectivorous creatures—have been so, in all probability, for ages past. This persecution might be supposed to foster any variation in shape or colour likely to be of protective value. And, as a matter of fact, the whole of the *Phasmidæ*, almost without exception, have undergone striking modifications in the direction of special resemblance.

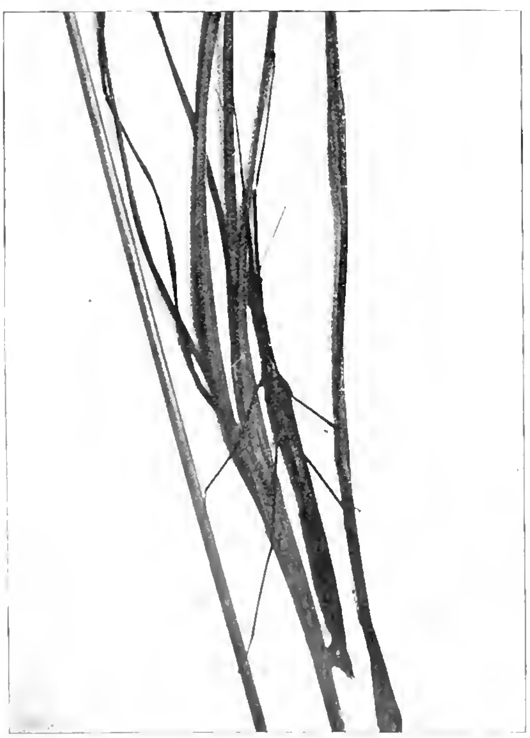
As a rule, the bodies of these insects have become greatly lengthened, while the legs are long and slender. Those known popularly as "walking sticks," of which the *Clitumnus sundaicus* shown in the accompanying photo-

graph is a good example, are generally of a uniform brown tint. Many of the species have curious knotty protuberances, or even prickles, upon their bodies and legs, this, of course, adding much to the stick-like aspect



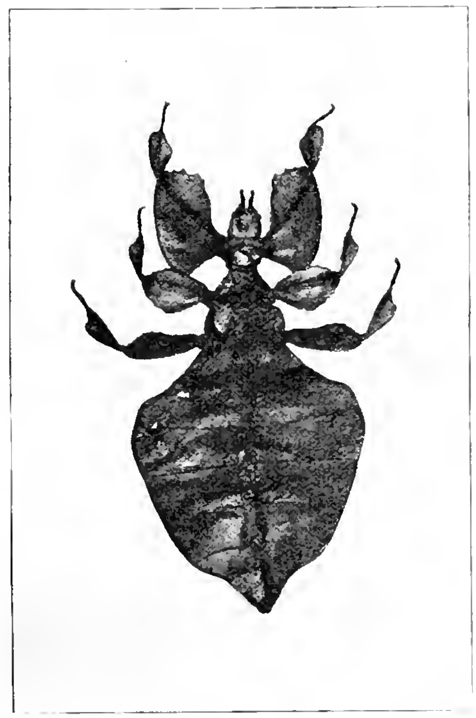
Winged Phasmid, showing two portions into which each wing is divided.

of the insect. After examining a dried specimen of a "stick" Phasmid, one does not need the assurance of foreign collectors to believe that these creatures are practically invisible when at home among the branches of their native shrubs.



Winged Phasmid, at rest among grass blades.

Other *Phasmidæ*—fairy-like creatures with exquisitely coloured wings—resemble grass rather than twigs when at rest. Their bodies, legs, antennæ, indeed every part of them, with the exception of certain portions of the wing area, is green. Their first pair of wings is rudimentary; but their hind wings are ample, gauzy, and fan-like in their manner of folding. A narrow strip at the anterior margin of each wing is thickened and green in colour, contrasting strangely with the gauzy area, which is usually bright pink. Under this narrow cover, the whole of the bright, flimsy portion of the wing is packed away when the insect comes to rest. And so closely are the wings folded that the casual observer imagines the creature to be apterous. It is, indeed, the exact counterpart of a crumpled or slightly-thickened grass blade, while its legs and antennæ are too slender to attract much notice.



Phyllium sp. Female. Ceylon.

Perhaps the most remarkable genus of the *Phasmidæ* is *Phyllium*, whose members—unlike the majority of their allies, which we have seen to be slender and lengthened—have the body and legs flattened into leaf-like plates. In some instances this design of leaf resemblance is carried out with amazing accuracy and attention to detail. Every portion of the insect seems modified to the one end. Its body is flat and leaf-like; its wings and wing cases (where present) look like leaves; while even its legs are flattened and fitted with leaf-like appendages. To crown all, the colour of these insects, when alive, is the brightest and freshest of vegetable greens; so that, when crawling among herbaceous foliage, a species of *Phyllium* is, to all appearances, not an insect at all, but just a moving mass of leaves.

Certain species of the *Membracidæ*, which are rather small, frog-hopper-like insects, have a most curious thorn-like or knot-like appearance. This is gained by an unusual development of the pronotum, which is produced behind into a long process, or, it may be, into a kind of shield. In the case of *Umbonia spinosa*, from Brazil, this

process extends completely over the insect, and is drawn upwards to a point. In fact, it is an exact imitation of a sharp vegetable thorn, from which it is indistinguishable. Thus, the *Umbonia* has merely to crouch down upon a thorny twig and withdraw its legs beneath the shield-like pronotum to be completely hidden.

The above examples include some of the more striking instances of protective resemblance, both general and special. They must not, however, be regarded as even typically exhaustive, for sticks, leaves, mosses, and lichens, though common patterns, are by no means the only objects copied in insect colour and form. Flowers, seed pods or seeds, patches of mould or decay, even the droppings of animals and birds are all prototypes for insect disguise. Moreover, the modifications of form and the varieties of colour and marking which have been called into being by the need for protection are too

Umbonia spinosa. Brazil. Middle "thorn" on upper part of Stem.

numerous even to tabulate. In the course of his investigations, every observant student will constantly have new and striking instances brought to his notice, even though he may never wander beyond the confines of his own county.

But it should be recollected that to form a true estimate of the protective value of an insect's colour and form, it is absolutely essential to study them in relation to their habitual surroundings; for, as a rule, it is quite impossible to tell from a casual examination whether a special appearance is protective or not. A butterfly in a cabinet drawer is merely a scientific specimen. Its colours may be bright and beautiful, dull and unattractive, as the case may be; but suspended above a surface of white paper, they have no special significance. On the other hand, when the insect is alive and among its natural surroundings, its colour and shape are often seen to have a direct bearing upon its well-being. Thus the study of living specimens cannot be too strongly urged upon the student—not of entomology alone, but of every branch of natural history.

A RATHER unexpected geographical discovery has been made by M. Gabriel Marcel, who in a Paris shop found an Eighteenth Century map on which is shown the project put forward by M. de la Bastide for a canal across the American isthmus by the Nicaragua route. The map, which is finely executed, is printed on silk, and from its shape was clearly intended for the decoration of a fan. It shows three ships in sail on the Lake of Nicaragua, and marks the suggested route to the west of the lake. Though M. de la Bastide's project is a matter of geographical history—he wrote a memoir on it in 1791—the map's existence had been hitherto unsuspected. His was a plausible project, but he did not by any means realise its difficulties, for he was a theorist who never visited the spot, and who depended on the very inaccurate maps of other people.

Professor Adam Sedgwick.

The Man and his Work.

WHEN, just over 30 years ago, at a meeting held in the Senate House, Cambridge, the idea was first mooted of a memorial to Professor Adam Sedgwick, it was said of him in the words of Shakespeare, "His life was gentle; and the elements so mixed in him that Nature might stand up and say to all the world, This was a man."

It is well at this moment, when the Sedgwick Museum is an actual commemoration, to recall the up-bringing and achievements of the subject of this splendid allusion.

The son of a Yorkshire clergyman, Sedgwick, at the close of his early education, proceeded to Trinity College, Cambridge, duly took a degree, and was classed as 5th Wrangler. In 1810 he was made a Fellow of his College, and engaged in teaching; and in 1816 was ordained. But it was not as a divine that his repute became established, but as a leader in British geology, a soldier in the early campaigns of the science. Elected Woodwardian Professor of Geology in 1818, although knowing, we are told, comparatively little of the study he was to teach, it seemed as if he was predestined for its successful prosecution, and it was not long before he stepped into the front rank as an original investigator. His lectures, which formed a novel feature when he entered upon the duties connected with the Woodwardian Chair, attracted general attention, while at the same time the Professor lost no opportunity of promoting and encouraging the extension of natural science teaching in the curriculum of university studies. Those were early days in geology—in fact, the long-clothes stage—and the authorities looked askant at the iconoclastic science, mindful, too, of what it might bring in its train. Undoubtedly, in the case of many other men, efforts to obtain the recognition of geological and allied studies would have been foredoomed to failure in the face of the frowning repressiveness which prevailed at Cambridge. But Sedgwick was endowed with special qualities for the task in hand, and never deviated from the chosen path. Moreover, his charming personality and adornments of character disarmed permanent opposition. Of these characteristics there is ample testimony in the opinions of his contemporaries. Three prominent hopes possessed his heart in the earliest years of the Professorship, in his own words expressed thus: "First, that I might be enabled to bring together a collection worthy of the University, and illustrative of all the departments of the science it was my duty to teach; secondly, that a Geological Museum might be built by the University, amply capable of containing its future collections; and, lastly, that I might bring together a class of students who would listen to my teaching, support me by their sympathy, and help me by the labour of their hands." The fulfilment of these hopes is, of course, a matter of history.

Sedgwick was the author of a lengthy series of papers in British geology, but he wrote no separate work. In particular is he known for his elucidation of the Palæozoic system, in which he collaborated with Murchison. He investigated the Magnesian Limestone of the North of England, and the geology of Wales engaged his earnest and successful study. He was elected a Fellow of the Royal Society in 1821, and in 1863 was awarded the envied Copley medal a year previous to the award

made to Darwin—for his observations and discoveries in the Palæozoic series of rocks, and more especially for his determination of the characters of the Devonian system. Other honours were showered upon him, both at home and from abroad, including, in the former category, the Presidency of the Geological Society and of the British Association.

As a contemporary of Darwin, Professor Sedgwick was confronted with that naturalist's theory respecting the evolutionary order of Nature. His attitude was uniformly hostile to the hypothesis, and he would have none of it. In this connection it is interesting to note that, at the time of the publication of the "Origin of Species," Darwin was exceedingly sore at the "rabid indignation" displayed by Sedgwick, nevertheless he took occasion to refer in affectionate strain to the veteran geologist's noble heart and instincts.

Sedgwick never married. He continued his occupancy of the professorial chair until his death, in 1873, which took place at the ripe age of eighty-eight, and he was buried in the ante-chapel of Trinity College.

Finally, let these words of his further proclaim the man: "My labour is its own reward. It gave me health, and led me into scenes of grandeur which taught me to feel in my heart that I was among the works of the great Creator."

Telegraphically Transmitted Photographs.

By Dr. Alfred Gradenwitz.

Many attempts have been made to transmit handwriting, photographs, drawings, &c., by telegraphic means, and the more or less successful solutions which have been suggested for this problem of late years are numerous. Selenium cells, as shown by Herr Ruhmer's successful experiments in the field of wireless telephony, give a ready means of detecting and transmitting by telephone even very slight fluctuations in the intensity of a source of illumination, and afford means of converting these fluctuations into oscillations of an electric current. If a light ray and a selenium cell be simultaneously drawn along over opposite sides of a photographic plate, the different shades of the various portions of the plate will result in continuous oscillations of the current being produced in the circuit of the cell. This is a common feature with all the sending devices used in the instruments of this class. The current oscillations are made to act on the receiving apparatus, which will reconvert them in turn into fluctuations of light. The design of the receiving apparatus has hitherto been the weak point with all these systems, because the electric currents transmitted are so very small. But a satisfactory solution of the difficulties so far met with seems to be afforded by the teleoptical apparatus of Professor Arthur Korn, Munich, as recently presented before the French Academy of Sciences.

While engaged in investigating the radiations given off by the electrodes of a tube exhausted to a pressure ranging between 0·2 and 2 mm. a Hertzian vibrations were applied to the electrodes, Professor Korn noticed the extreme sensitiveness with which these radiations would react on small alterations in the circuit. This sensitiveness suggested a possible utilisation of those radiations which were photographically most efficient, in connection with a method of electrical telephotography.

The apparatus, based on the above principle, is shown in fig. 1.

The photographic film *a* of the receiver rotates in front of a small window *c* (0·25 mm × 0·25 mm) in an exhausted tube *b*, like a roller, in front of the vibrating membrane of a phonograph. The surface of the tube is coated with black paper and tin-foil, leaving only the window. By means of high frequency currents (Tesla currents), luminous radiations may be produced inside the tube, and these, after passing through the small window, will make photographic impressions on the sensitive film. The latter is moved synchronously with the image-holder A of the sending-apparatus (a film bearing the photograph to be transmitted wound on a glass cylinder), which is traversed by a very thin beam of light B C D while passing, line per line, before a selenium cell D placed inside the cylinder. According to the different shades in the photograph transmitted, the selenium will receive more or less light, while an electric current, passing through the selenium D and the telegraphic wire F up to the receiving apparatus, will undergo corresponding variations of intensity, thereby regulating the intensity of the radiations of the receiving tube. This is provided for in the following way: The active electrode *e* of the tube being connected to one of the poles *p*, of the secondary coil of a Tesla apparatus, by inserting fields of sparks formed by the points m_1, m_2, of a galvanometer needle *l* and two fixed points f_1, f_2, the intensity of the radiations given off by the tube will be more or less great, according to the distances m_1 f_1 and m_2 and f_2, which are variable along with the transmitted currents passing through the galvanometer *g*. By the use of this arrangement, a means is afforded of making the intensity of the radiations of the receiving tube correspond with the intensity of the light striking the selenium of the sending-apparatus, thus reproducing line per line of the original photograph.

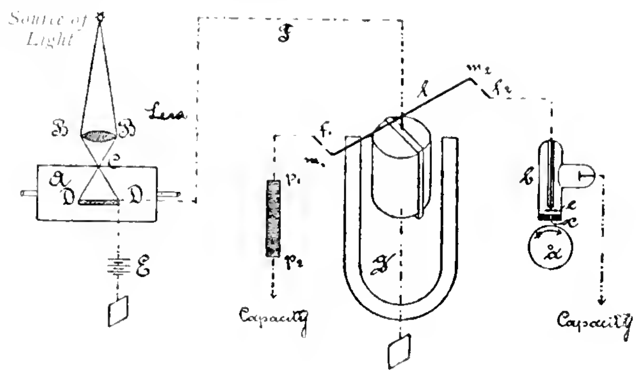
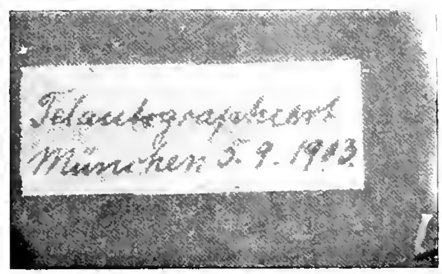


Fig. 1.



Original Photograph.

Transmitted Photograph.

The telephotographic receiver may, as well, serve as a telautographical receiving-apparatus, i.e., an apparatus for reproducing handwriting, drawing, &c., at great distances. In this case, only some very slight alterations will have to be made, and a Bakewell-Caselli transmitter used. The speed attained is relatively very high. It has been found possible to reproduce from twenty to forty words in the

Original Photograph.

original handwriting in the course of three minutes, and in the case of shorthand much higher speeds may be arrived at. The transmission of photographs, of course, is slower, principally on account of a certain inertia of the selenium. The progress lately made in connection with the construction of selenium cells, however, makes much higher speeds very probable. The time at present required for telephotographing a portrait is about half-an-hour.

Transmitted Photograph.

Figs. 2 and 3 show the telegraphic reproduction of a photograph and a telautographic specimen respectively. The inventor wishes us to state that part of the imperfections of the photo. especially the stripes, is due to the experiments having been made in the Physical Laboratory of the Munich University, where the pressure of the battery and, accordingly, the intensity of the source of light, would undergo frequent fluctuations.

Modern Views of Chemistry.

By H. J. H. Fenton, F.R.S.

In our last communication we indicated very briefly, in outline, the nature of the ionic-dissociation hypothesis, and mentioned some of the experimental facts upon which it is based; we propose now to give a few illustrations of the manner in which the hypothesis has been applied to the explanation or interpretation of some well-known chemical and physical facts.

What is an acid? Everyone who is at all acquainted with the elementary facts of chemistry has a fairly clear conception in his own mind what the term implies, but attempts to frame an exact definition are not always satisfactory. If an acid is "any hydrogen compound which can exchange its hydrogen, wholly or partly, for a metal when the latter is presented to it in the form of a hydroxide," we must include as acids substances such as zinc hydroxide and aluminium hydroxide, the distinction between acid and base being relative rather than absolute. It was at one time proposed to restrict the term "true acid" to a compound which can behave in the above manner even in presence of much water, and such a restriction would, it is true, exclude substances like zinc hydroxide, but it would also exclude some compounds like silicic acid which are looked upon as acids. Other definitions, such as "a salt of hydrogen," "a compound which can evolve water by its action on caustic potash," or "a compound of hydrogen with an electro-negative element or group," can generally be found fault with, and there is often a tendency to define the terms "acid," "salt," "base" in a circle.

The ionic-dissociation hypothesis now comes to the rescue with an elegant and simple definition. An acid, it says, is a compound whose aqueous solution contains free hydrogen ions. What we call acidity or acid-property in a solution is due to these ions, and is more pronounced as their concentration is greater, i.e., the more there are in a given volume. A base, on the other hand, is a compound whose aqueous solution contains free hydroxyl (O H) ions, and when an acid neutralises a base the only change which takes place (provided the solution is dilute and the acid and base are "strong") is the union of the free hydroxyl and hydrogen ions to form water. It will be observed that, according to this conception of the matter, neither the metal or acid radicle takes any part in the change; they remain as free ions throughout:—

$$H + R + M + OH = M + R + HOH$$

(where R is the acid radicle and M the metal).

It must not be forgotten that the older definitions alluded to above are practical ones, whereas this ionic definition depends entirely upon hypothesis; the latter, however, affords a remarkably simple explanation of many well-known facts. When, for example, equivalent weights of strong acids (say, hydrochloric or nitric) neutralise strong bases (say, caustic potash or soda), the quantity of heat evolved is always the same. This fact is easily understood on the above supposition, since in each case the only change in the arrangement is the union of hydroxyl with hydrogen.

If the acid or base, or both, are not "strong," the heat change on neutralisation will be different from that in the previous case. This is explained by saying that the weaker acids and bases are not entirely in a state of

"ionisation" or dissociation to begin with, and require to be further broken up before the hydrogen and hydroxyl can combine.

What exactly is to be understood by the *strength* of an acid or a base was for a long time the subject of dispute. It used to be said that sulphuric acid was stronger than hydrochloric or nitric acids, because it "turned them out" from their combinations with bases. Sodium nitrate, for example, when distilled with sulphuric acid, gives sodium sulphate and free nitric acid. The test of strength, however, when applied in this manner, is not legitimate, since the nitric acid is not given a fair chance; it is removed from the sphere of action by vaporisation. A much more rational way of arranging the encounter was that devised by Thomsen when he mixed, in dilute solution, one equivalent weight of each acid with one equivalent weight of base. Here there is insufficient base to satisfy both acids, and all the substances concerned, before and after the action, remain dissolved together without any removal. The two acids then strive for the base, and the one which gets most of it is the "strongest." In this way it is possible to arrange the acids in the order of their "strength," and experiment showed that hydrochloric and nitric acids head the list in such an arrangement.

Sulphuric acid proves to be only about half as strong as nitric or hydrochloric acids—a result altogether at variance with the older ideas.

The problem has been attacked also from various other points of view: it is known, for example, that the salts of weak acids or weak bases may undergo what is called hydrolysis in aqueous solution, that is to say that

$$\text{Salt} + \text{water} = \text{acid} + \text{base}.$$

Such an action can easily be shown in the case of ferric chloride or sodium borate. It was proposed, therefore, to classify acids as weaker or stronger according to the extent to which their salts were "hydrolysed" by water under similar conditions.

Again, there are many chemical changes which are found to be greatly accelerated by the presence of acids, and if these changes happen to be sufficiently slow to enable one to map out the rate of change, it is possible to compare the influence of different acids. Results obtained in such ways agree, on the whole, remarkably well with the order of "strength" as measured by the "striving for base" method.

The electric conductivity again was found to be better for the stronger acid; and the same is true with regard to the deviation from the "normal" osmotic pressure above referred to (Article I.). Such observations were largely instrumental in leading up to the new theory. If one "believes in ions,"* it is a comparatively simple matter to explain, in terms of the hypothesis, what is meant by the "strength" of an acid. The strongest acids, like nitric and hydrochloric acids, undergo complete, or nearly complete, ionisation when dissolved in a moderate volume of water, whereas the weaker acids, like acetic or hydrofluoric acids, are ionised to a less extent. In other words, a moderately diluted solution of hydrochloric acid contains a (relatively) large number of free hydrogen ions in a given volume, and an equivalent quantity of acetic acid contained in the same volume gives rise to (relatively) few free hydrogen ions.

But ionisation increases as dilution increases, so that we arrive at the conclusion, which sounds paradoxical at first, that when their aqueous solutions are infinitely diluted all acids would be equally "strong"!

The strength of an acid, then, depends, according to these ideas, upon the concentration of the free hydrogen ions which is attained when an equivalent weight of the acid is dissolved in water and the solution made up to a given volume. But how are we going to measure this, or compare it, say, in the case of two given acids?

The complete explanation of the way in which this can be done would perhaps be out of place in a brief sketch like the present one; we will merely attempt here to give a very rough indication of the principle.

The electric conductivity of an acid in solution depends upon the number of free ions present in a given volume and upon the speed with which they move. If we determine (directly or indirectly) the molecular conductivity of a given acid (1) when the solution is moderately dilute, and again (2) when it is infinitely dilute, it can easily be shown that the first number divided by the second will tell us the extent to which the acid is ionised in the moderately dilute solution. We can then make similar experiments with other acids under the same conditions, and so compare the extent to which each is ionised. Assuming for simplicity that each acid splits up into two ions, one of which, of course, is hydrogen, it is evident that the one which is most ionised is the strongest under the given conditions, *i.e.*, there will be more free hydrogen ions in a given volume of solution.

The extent of ionisation of the acid can also be arrived at from other considerations, such as the deviation from the normal osmotic pressure (see Article I.); but the electric conductivity method is the most generally applicable.

* At the present time it is well to look upon this ionic explanation as a very efficient and complete working hypothesis, and not to regard it, as is often done, in the light of a creed or dogma.

The Problem of Cancer

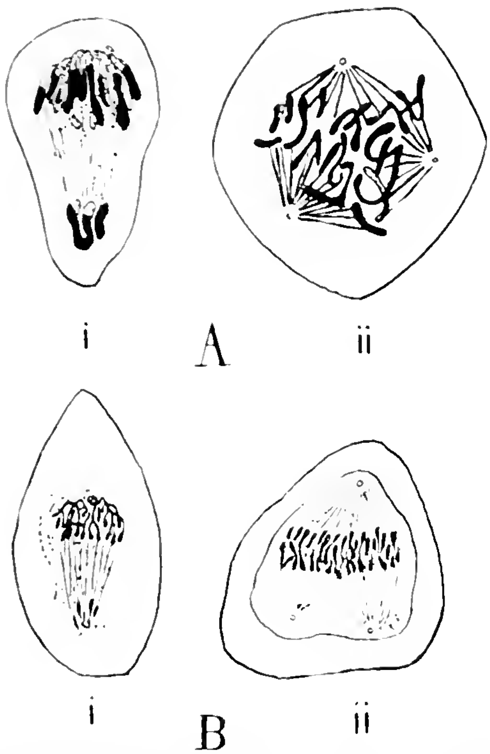
By FELIX OSWALD, B.A., B.Sc.

THE failure of bacteriologists to discover a cancer-bacillus has facilitated future investigation regarding a probable cure for cancer by narrowing the issue and disposing of a fruitless line of research. On the other hand, the recent important discovery of Professor Farmer and his colleagues, that cancer-cells agree with reproductive cells in only containing half the number of chromosomes in the nucleus after nuclear division, recalls the experiments of Galeotti, in 1893,* with regard to the unsymmetrical and irregular nuclear division in cancer-cells. It appears probable that the efficacious preventive treatment of cancer is to be sought in the direction indicated by these experiments, which have hardly received the attention they deserve. Briefly stated, Galeotti treated actively dividing, epithelial cells of salamanders with dilute solutions of drugs such as antipyrin, chloral, quinine, cocaine, nicotine, potassium iodide, &c. The action of these substances caused asymmetrical and tripolar division of the nucleus, exactly similar—as the accompanying figures will show—to the asymmetrical and tripolar division which takes place in cancer-cells in a human subject. The remarkable similarity between these pathological occurrences

* Beitr. zur patholog. Anatomie und zur allgem. Pathologie, XIV 2; Jena, 1893

points to the inevitable conclusion that cancer is primarily due to an irritant poisonous substance, that such substance is secreted in a spot liable to disease, *e.g.*, in glandular tissue, and that the blood is unable to carry off or neutralise the deleterious matter.

The problem of an ultimate cure for cancer would seem, therefore, to lie in the chemist's sphere rather than the surgeon's, *viz.*, firstly, in the careful analysis of fresh cancerous tissue, and the isolation of the irritant principle; and, secondly, in the discovery of an antidote to be injected into the system just as antitoxin is injected for diphtheria, to assist the blood in its function of eliminating the injurious substance. It is a suggestive fact that antagonistic drugs are known to the substances which Galeotti used in creating the pathological nuclear divisions so



A.—Epithelial Cells of Salamander, showing (i.) unsymmetrical nuclear division after treatment with 0·05 per cent. antipyrin solution; (ii.) tripolar division after treatment with 0·5 per cent. potassium iodide solution. B.—Human Cancer Cells, showing (i.) unsymmetrical, and (ii.) tripolar nuclear division. [Both after Galeotti

similar to those of cancerous tissue, *e.g.*, strychnine is antagonistic not only to nicotine, but to chloral, to which atropine also shows antagonism.

The similarity between cancer-cells and reproductive cells in containing only half the usual number of chromosomes compared to normal somatic cells, and the further discovery that the nuclei of *all* the cells in the sexual generation (prothallus) of a fern show this reduction, would seem to indicate that the occurrence of cancer-cells in the bodies of man and higher animals shows a tendency to a reversion to the remote state of things when every single cell of the reproductive generation partook of this peculiarity of the reproductive cell. It would be interesting in this respect to ascertain whether the cells of the sexual generation in lowly creatures of the animal kingdom, such as liver-flukes, jelly-fish (*Aurelia*), and some Tunicates (*Salpa*), &c., which exhibit an alternation of sexual and asexual generations, show the same condition as the fern prothallus in the vegetable kingdom.

Rare Living Animals in London.

By P. L. Sclater, F.R.S.

In the annual reports of the Zoological Society of London will always be found a section containing a list of the species new to the collection exhibited during the preceding year, and though, as we all know, it is continually becoming more difficult to find "something new" in any class of objects, it will be seen, on reference to the reports, that even in the most recent years the list of novelties is by no means a short one. There are, in fact, always a considerable number of recent additions to the Zoological Society's living collection of much interest, and well worthy of representation by the facile fingers of the artist, which we believe to be a much more generally effective way of bringing the points of their shape and structure into notice than the cheaper and more fashionable photographs of the present day.

It is with great pleasure, therefore, that I have undertaken to write a few remarks on some of the rare and interesting animals in the Regent's Park that have lately formed the subjects of Mr. Goodchild's skilful pencil.

1. The Thylacine.

(*Thylacinus cynocephalus.*)

In the late Sir William Flower's excellent "Introduction to the Study of Mammals" the threefold division of that order, originally proposed by Blainville, into "Ornithodelphia," "Didelphia," and "Monodelphia" is fully maintained, although, for good reasons, Huxley's change of these names into "Prototheria," "Metatheria," and "Eutheria" is adopted, as being "far less open to objection." The Metatheria, as Flower points out, are represented in the present epoch by numerous species which offer considerable diversities in appearance, in structure and in habits, although they all agree in many anatomical and physiological characters which give them an intermediate position between the Prototheria and the Eutheria. The most important of the latter set of characters is that the young of the Metatheria are brought forth in a rudimentary condition, and are nourished by milk injected into their mouths from the maternal mammæ, to which they are firmly attached for some time after their birth. During this process the young, in nearly all cases, are sheltered in an abdominal pouch or *marsupium*, whence the Metatheria have received the more familiar name of "Marsupials."

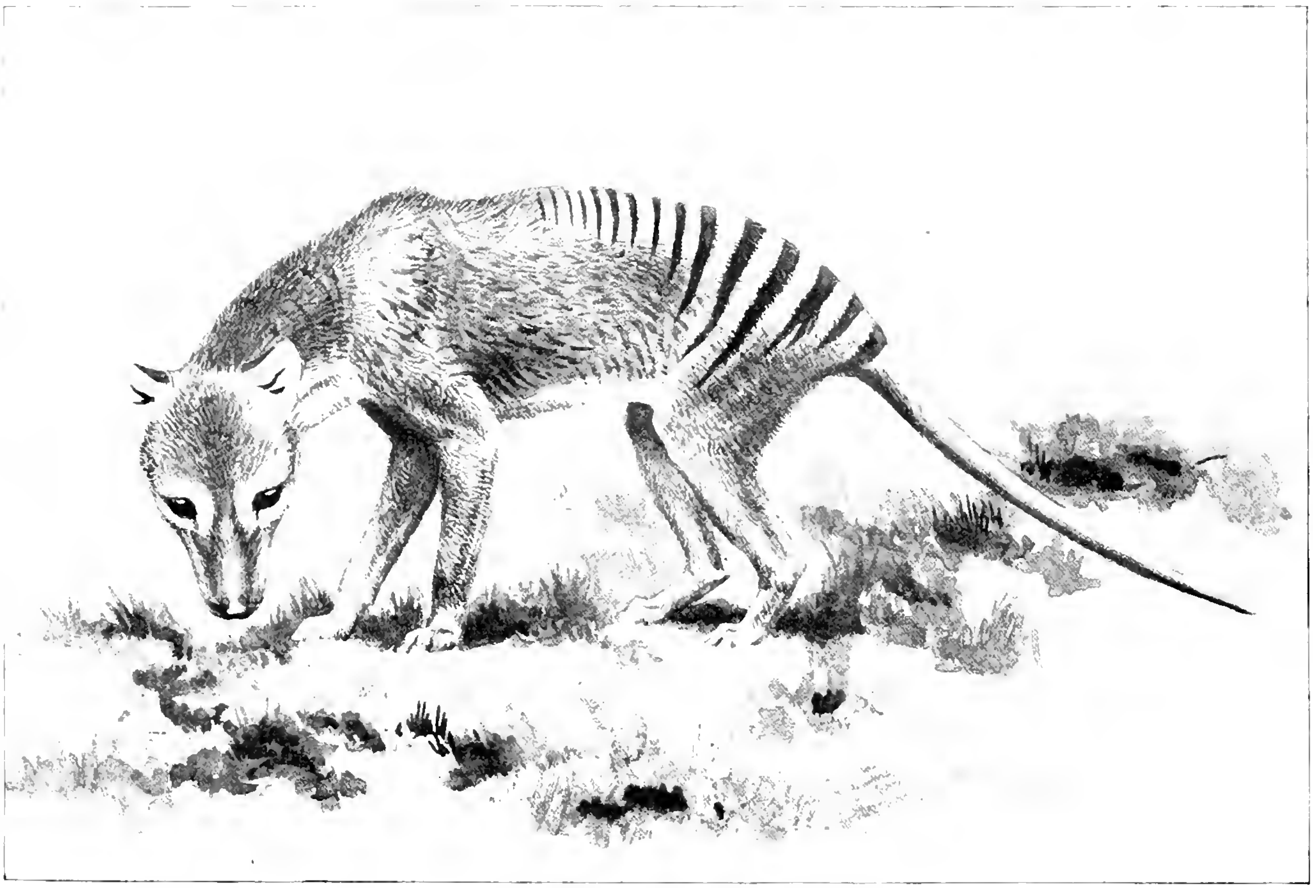
The Marsupials then, as we will call them, are usually divided into two sections, the Diprotodonts and the Polyprotodonts. Of the former of these, which with a few unimportant exceptions are vegetable feeders, the best known are the kangaroos of Australia and the adjacent islands, while of the Polyprotodonts, which are carnivorous and insectivorous, the finest and largest representative now living on the earth's surface is the Thylacine of Tasmania, the animal represented in the accompanying drawing.

On first seeing the Thylacine alive the uninformed spectator would naturally take it for a dog or a wolf. And indeed in general external appearance the Thylacine is excessively like one of these animals, but it is, nevertheless, undoubtedly a Marsupial in every essential part of its structure, and like most other members of the

Metatherian group carries its new-born young in an abdominal pouch. It is also at once distinguishable from a wolf by its long, tapering, and thinly haired tail, as is well shown in our picture, and by the curious transverse stripes on the back, which are very prominent in the living animal.

The Thylacine is a native of Tasmania, and is not found in any other part of the world, although in a former geological epoch an allied form, which has been named *Thylacinus spelaus* by Professor Owen, existed in the adjacent parts of Australia. In Tasmania the Thylacine is the only specimen of the Thylacine now alive in Europe.

The first living Thylacines ever received by the Zoological Society were a young pair presented by their Corresponding Member, Mr. Roland Gunn, of Launceston, in 1840. They had been captured in snares on the upper branches of St. Patrick's River, about thirty miles N.E. of Launceston, and lived many years in the Regent's Park. The same generous friend, learning that these animals were no longer alive, sent a second pair in 1863, which likewise did well in the Society's Gardens. Thyla-



I. The Thylacine (*Thylacinus cynocephalus*)

is said to be popularly known as the "tiger" or "hyæna," from its rapacious habits, but is also often called, more appropriately, the "Tasmanian wolf."

In former days, when Tasmania was first peopled by Europeans, the Thylacine was common in all the rocky and mountainous districts of the island, and at that time found an abundant supply of food in the native kangaroos and bandicoots. But when sheep were introduced into the Colony, and bred in large numbers, the Thylacine soon learned to attack the sheepfolds, and consequently became an object of persecution to the Tasmanian shepherds, whose fierce hostility has now brought it to the verge of extinction. Of late years, indeed, very few living specimens of it have reached Europe, and the Zoological Society is fortunate in having secured the fine young male example now figured, which was obtained by purchase in March, 1902. So far as I know, this

cines in captivity are very active in their movements when excited, but somewhat nocturnal in their habits. They are usually fed on mutton.

Blake's Historical Charts.

MR. WILLIAM BLAKE has compiled a series of Historical Charts, designed to show in a sort of bird's-eye view the course of English History in different year periods. Chart No. I. gives a general view of English History from 1066 to 1902. Chart No. II., intended to be used with the other Charts, and a most useful supplement to them, gives contemporary European rulers from 1066 to 1902. Succeeding Charts cover various phases of English History from the Roman Dominion in Britain to the reign of Queen Victoria. The Charts have been very carefully compiled at the cost of immense labour, and are designed for the use both of students and teachers.

The Ancestry of the Carnivora.

By R. Lydekker.

Compared with the more advanced types of ungulate, or hoofed, mammals, such as the horse, the camel, and the true ruminants, all the Carnivora are in many respects much less specialised animals, more especially as regards the structure of their limbs. By this I mean that although all of them are thoroughly adapted to their own special mode of life, while in many instances they are some of the most active, most highly organised, and most intelligent of all animals, yet they depart much less widely from the primitive type of mammals in general than is the case with the more specialised ungulates, or indeed, than ungulates collectively. In none of them for instance, does the number of toes on each foot ever fall below four, while in some cases the typical five digits are retained in at least one pair of feet. Then again, although in the members of the cat tribe specialisation is displayed by the development of sheaths for the protection of the sharp and sickle-like claws, the terminal joints of the toes are always of the primitive claw-like type—the unguiculate form, as it is termed by naturalists, and never make any approach to either nails or hoofs. Moreover, all the Carnivora are characterised by the absence of that tendency to a reduction of the number of the bones in the limbs by the fusion of two together and the disappearance of others, which, as we have seen, form such striking features in the evolution of the more specialised types of hoofed animals. Such consolidations and reductions in the bony framework are indeed strictly correlated with and necessary to the development of a small number of hoofs on each foot, and are, therefore, from the very nature of the case, conspicuous by their absence in the Carnivora. Indeed, if we except the frequent disappearance of the collar-bones, or clavicles, the skeleton shows none of that amalgamation or loss of some of its elements, coupled with the excessive development of others, which are such noticeable features in the more specialised ungulates.

Then, again, the teeth of the Carnivora, though admirably adapted to the special needs of their owners, are much less widely removed in structure from the primitive, or generalised, mammalian than are those of the higher hoofed mammals. The cheek-teeth, for instance, never display that heightening or broadening of the crown, coupled with those deep infoldings of the grinding surface, seen in the molars of the horse and the ox. Moreover, unlike what so frequently takes place in the ungulates, the front teeth are always well developed, and rarely fall below the typical mammalian number of three pairs of incisors and one of canines, or tusks, in each jaw. Indeed, when a reduction in the number of the teeth does take place, as in the cats, whose short jaws do not leave room for the full complement, such reduction takes place at the hind end of the series.

Among living Carnivora the group which is in the whole the most generalised and the least widely removed from the primitive ancestral type is that of the dogs—including under this name not only the animals properly so called, but likewise wolves, jackals, foxes, etc. To enter into a consideration of the structure of the skeleton would obviously be an impossibility on this occasion, and it must accordingly suffice to mention that while the typical number of five toes are retained in the fore-foot of nearly all members of the group, in the hind foot there are only four; and that although collar-bones are developed, yet they are reduced to mere rudiments. One other important circumstance in connection with the skeleton must, however, be noticed. If the bones of the wrist, or carpus, of a dog be compared with that of man or of most other mammals except Carnivora, it will be noticed that the upper row consists of two, in place of three, elements. This is due to the fusion of two of the bones, the scaphoid and lunar; and this union is characteristic of all modern Carnivora, in which the compound bone is known as the scapho-lunar.

One other feature—and this connected with the dentition—is very characteristic of modern land Carnivora. In the skull of a cat, dog, or wolf (fig. 1) it is well known that one pair of teeth in the side of each jaw differ markedly in size and structure from all the rest, the upper biting upon the lower pair with a more or less scissor-like action. It is with this pair of specialised teeth that a tiger or a lion cuts up the masses of flesh torn from its prey into convenient lengths for swallowing; and these formidable weapons are consequently known as the carnassial, or flesh, teeth. Curiously enough, these teeth do not serially correspond with one another. It will be seen, for instance, both in figure 1 and figure 2, that while

Fig. 1.—Side view of skull of Wolf to show the carnassial teeth.

the upper carnassial is the fourth from the tusk, the corresponding lower tooth is the fifth from the latter; both the species in the two illustrations referred to having the full typical series of anterior cheek-teeth. Nor is this all, for whereas the upper carnassial has no deciduous predecessor ("baby tooth"), the corresponding lower tooth succeeds a deciduous baby tooth. Consequently, the upper carnassial—to employ technical language—belongs to the premolar series, while the lower carnassial is one of the true molars.

Now, when we find two organs which do not serially correspond with one another, modified for some particular function, it may be at once taken for granted that this is a highly specialised condition which did not obtain in the beginning; and this we shall find to hold good in the case of the Carnivora.

From the general presence of this peculiar type of dentition, all the modern Carnivora, together with many of their extinct relatives, are collectively known as the Carnassidentia. Not that it must be assumed that this feature is common to them all. In the bears, for instance, the carnassials, although still displaying traces of the characteristic structure, have become comparatively small and weak teeth, much smaller than the grinding molars behind. And this degeneration (for by means of fossil forms the feeble carnassials of the bears can be traced

into the fully-developed ones of the dogs) may be explained by the nature of the food of bears, which does not require the action of scissor-like teeth.

Again, in the seals and walruses there is no trace of a differentiated pair of carnassial teeth; such a type of dentition being unnecessary to animals living on a fish diet. In the case of the eared seals and walruses, there is little doubt that the absence of differentiated carnassials is due to degeneration, these creatures being apparently related to the bears. The case of the true, or earless, seals is more uncertain; and it has been suggested that these creatures inherit their distinctive type of dentition direct from an extinct group referred to below. Against this is the circumstance that they possess the compound semilunar bone in the wrist, which, on the above view, would imply the fusion of the two elements entering into its composition in two independent instances.

Reverting to the existing members of the dog tribe, it will be noticed that the skull (fig. 1) is characterised by its elongated form and relatively large brain-cavity. The teeth fall short of the typical mammalian number of 44 only by a single pair—namely, the last pair of molars in the upper jaw. Consequently there are only two pairs of teeth behind the upper carnassial. In the lower jaw the last molar is very small, and evidently on the point of disappearance. As regards the other teeth, it must suffice to mention that the carnassials are strongly developed and possess a perfect shearing action, the lower one having a large tubercular portion for masticating behind the cutting blade; and that most of the premolars (other than the upper carnassial) carry accessory cusps on either side of the main cone. It may be added that all the existing members of the family are digitigrade—that is to say, they walk on their toes instead of on the sole of the foot, which is raised above the ground and covered with hair.

A large number of extinct dog-like animals have left their remains in the Tertiary strata of both Europe and North America; those from the newer formations being nearly allied to existing types, while the older forms are more or less decidedly different. One of the most important of these extinct types is the Oligocene and Miocene genus *Cynodictis*, which is without much doubt the ancestral type of the true dogs (*Canis*) of the present day. Although generally having the same dental formula as the latter, *Cynodictis* exhibits distinct signs of affinity with the ancestors of the civets. On somewhat the same platform of evolution as *Cynodictis* is the North American *Daphænus*, of which the skull is shown in fig. 2. In this animal it will be seen that a small third upper molar (the third tooth behind the carnassial) is retained, thus

Fig. 2.—Skull of *Daphænus*, a primitive Dog from the Middle Eocene strata of the United States, with a crown view of first and second lower molars. (After Dr. Wortman.)

bringing up the number of the teeth to the typical 44. In general characters, the dentition is very similar to that of modern dogs, but there are fewer accessory cusps to the premolars, and the posterior portion of the lower carnassial is adapted for cutting, instead of for grinding. The dogs of this genus are further remarkable for the shortness of their jaws; and it has accordingly been thought that they may have been the ancestors of the modern wild dogs (*Cyon*) of Asia.

Great interest attaches to another type of Tertiary dog, the *Amphicyon* of the Miocene and Oligocene strata of both hemispheres, some of the species of which attained dimensions rivalling those of a bear. This interest is due to the fact that these giant dogs, which had 44 teeth, and partially plantigrade feet, were the actual ancestors of the modern bears, with which they are connected by certain extinct genera. We thus establish the derivation of bears from dogs of a generalised type.

All the foregoing extinct general types of dogs may, however, themselves be apparently derived from a still more generalised form from the Middle, or Bridger, Eocene of North America, known as *Vulpavus*. In this animal, which can only be tentatively included in the dog family, the skull (fig. 3) is characterised by its long and narrow

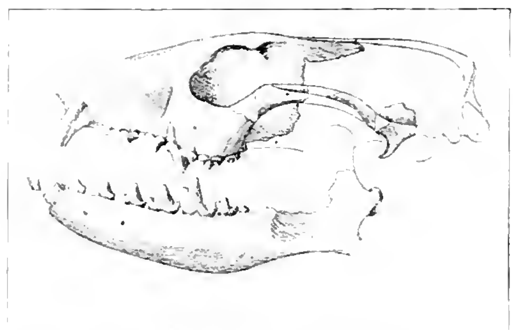


Fig. 3.—Skull of *Vulpavus*, an ancestral type of Dog from the Bridger Eocene. (After Wortman.)

form, and the small size of the brain-cavity. The teeth, of which there are 44, are of a decidedly dog-like type, but the outer front angles of the upper molars assume a cutting character, and the blade of the lower carnassial is much taller and narrower, and also more obliquely placed, than in the dogs, while the second and third lower molars, although much smaller, present a decided resemblance to the carnassial. Moreover, the lower premolars have large fore-and-aft cusps, differing in character from those of the true dogs. Unfortunately, the structure of the wrist is unknown, but it is quite possible the scaphoid and lunar bones may be separate. The hind as well as the fore feet were five-toed.

More or less nearly allied to *Vulpavus* are certain other Lower Tertiary Carnivora, exemplified by the genus *Viverravus*, which are regarded as forming the most primitive family of Carnassidents at present known. They have five-toed feet, with the scaphoid and lunar of the carpus separate; and the dentition, in which the number of the teeth may be either 44 or 40, differs from that of *Vulpavus* by minute details, to which it is impossible to refer on this occasion. In certain numbers of the family, such as *Oodectes*, the last two lower molars are exceedingly like the carnassial, and have their crowns but little lower, although these teeth retain the essential carnassident feature of being smaller than the latter. In other respects, the dentition of these primitive forms comes very close to that of the under-mentioned creodonts, with which the *Viverravidæ* also

agree in their divided scaphoid and lunar. As indicated by the name of the typical genus, the *Viverravidæ* are regarded by American palæontologists as the ancestors of the civets (*Viverridæ*) of the old world; and it is not improbable that they were likewise ancestral to the primitive dogs. If it be added that there is evidence to show that the members of the weasel tribe are also sprung from a more or less nearly allied Eocene group, we shall have accounted for the origin of four of the most important families of existing land Carnivora, namely dogs, bears, civets, and weasels. As regards hyænas, there is little doubt that they are closely related to civets, with which they appear to be connected by a number of extinct forms, such as *Ictitherium*.

Leaving the raccoon family alone, it may be added that there is still some degree of uncertainty with regard to the origin of the cats (*Felidæ*). Unless, however, they trace their origin direct to the undermentioned creodonts, there seems to be considerable probability that they are derived from the imperfectly known family of primitive carnassidents termed *Palæonictidæ*, all the members of which are characterised by their short jaws and cat-like dentition. In the typical *Palæonictis*, which dates from the Wasatch, or Lower, Eocene, the carnassials are somewhat imperfectly differentiated from the other teeth; but in *Ælurotherium* of the Bridger they become well characterised.

Having thus traced, more or less definitely, most of the principal families of existing land Carnivora to generalised forms which are evidently on the borderland between the Carnassidentia and some more primitive type of Carnivora, we have to turn our attention to what is known with regard to the latter.

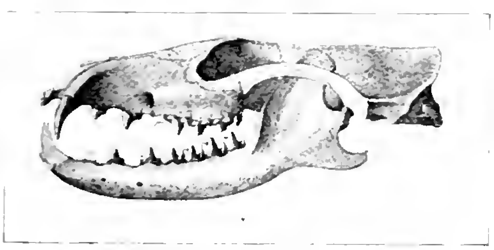


Fig. 4.—Skull of ***Sinopa*****, a North American Creodont. (After Wortman.)**

Such primitive type is represented by the Eocene and Oligocene Carnivora collectively known as Creodontia, of which the American* *Sinopa* or *Stypolophus* (fig. 4) and the European *Hyænodon* and *Pterodon* (fig. 5) are well-known representatives. In addition to other features which cannot be noted here, these creodonts are collectively characterised by three long, narrow, small-brained skulls, by the fact that the scaphoid and lunar of the wrist are usually distinct, and, above all, by the non-development of a pair of differentiated carnassial teeth. In place of these, the lower jaw (fig. 5) has all the three molars of a cutting type (m^1, m^2, m^3); and it will be further noticed that these teeth differ from the corresponding teeth of a carnassident by the circumstance that they increase in size from the first to the third, instead of decreasing. These animals all have five-toed feet, in which the thumb and the first toe may be opposable to the other digits.

Unless these creodonts have given rise to the true seals of the present day, they seem all to have died out during the Tertiary period without leaving any descendants. Moreover, they appear to have been derived from some still more primitive stock independently of the carnassidents, with the earlier form of which latter they were, however, evidently allied. In other words, carnassidents and creodonts appear to be diverging branches from a single primitive stock, which probably lived during the Secondary, or Mesozoic, epoch.

Fig. 5.—Lower Jaws of Creodonts and Marsupials. 1 *Hyænodon*, 2 *Pterodon*, 3 *Borhyæna*, 4 *Thylacinus*.

What were these Mesozoic ancestors, is the next question which presents itself.

A comparison of the lower jaws of the creodont *Hyænodon* and *Pterodon* with that of the marsupial *Thylacinus*, as displayed in fig. 5, shows at a glance that the dentition in all three is of the same generalised type; this being especially indicated by the form and relative dimensions of the three molars. It is true, indeed, that in the marsupial there appear to be four of these teeth; but this is due to the fact that the tooth in advance of these (m.p. 4) is a persistent milk-tooth, which is not replaced, as in the creodonts, by a permanent premolar (pp. 4). Certain South American extinct types such as *Borhyæna* (fig. 5, 3) are intermediate in regard to the number of teeth replaced between creodonts and marsupials, in the latter of which only one (pp. 3) is so changed, and it is consequently a difficult question to say whether these South American forms should be classed as creodonts or marsupials.

Be this as it may, it is quite evident that creodonts and marsupials are nearly related, and have probably both sprung from Mesozoic ancestors. The next question is whether these Mesozoic ancestors should be called creodonts or (in a wide sense) marsupials. Unfortunately the degree of preservation of the comparatively few and imperfect known remains is such as to preclude a definite answer being given to the question. Dr. Wortman, to whose opinion I attach great value, inclines to the belief that they were marsupials. Personally, basing my opinion on the restricted tooth-

* Represented in Europe by the closely allied *Cynohyænodon*.

change of the latter, I am more disposed to call the Mesozoic forms primitive creodonts, and to consider creodonts as the ancestors of marsupials, rather than *vice versa*.

The whole question is, however, absolutely bristling with difficulties and uncertainties, and involves the discussion of a number of technicalities which cannot possibly be touched upon here.

With this, then, I must leave the subject, merely adding that after having traced the specialised modern Carnivora into early types closely allied to the primitive Creodontia, and having also pointed out the existence of a near affinity between the latter and the carnivorous marsupialia, the question naturally arises whether the middle Mesozoic mammalian forerunners of these groups may not themselves be the descendants of the carnivorous mammal-like reptiles (theriodonts) of the early part of the same epoch, which have a typical carnivorous type of dentition. If so, the dog and civets of our own day have a truly ancient pedigree.

Is there Snow on the Moon?

A Study of the Lunar Apennines.

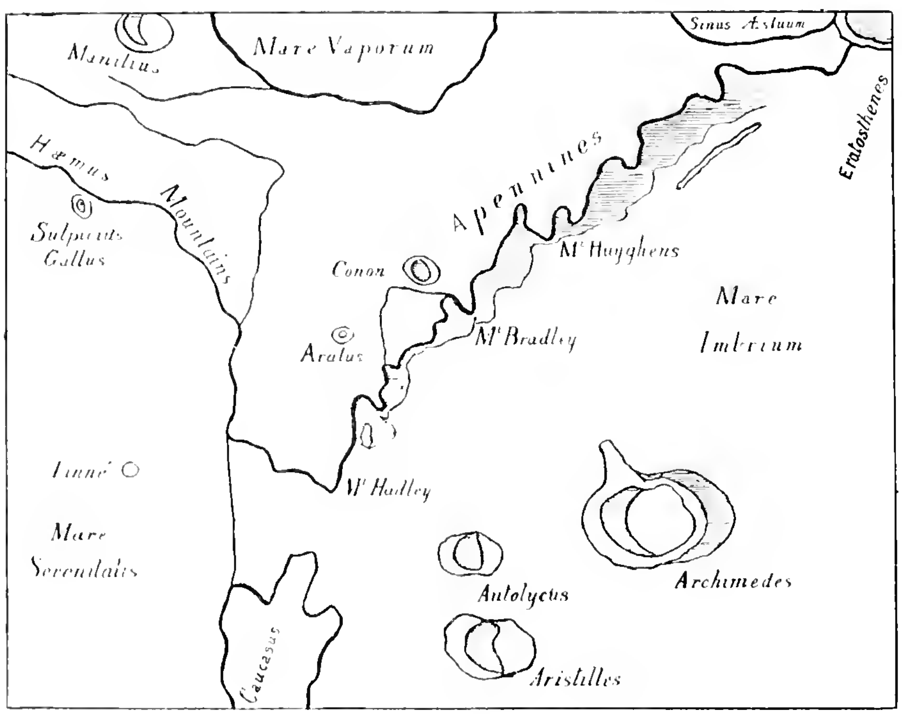
By E. WALTER MAUNDER, F.R.A.S.

THE principal object in the accompanying Plate, which is reproduced from one of the superb photographs taken by MM. Loewy and Puiseux, with the great equatorial coude of the Paris Observatory, is the range of the lunar Apennines, by far the grandest mountain chain upon the moon, and the one which, at first sight at least, most strongly resembles those of our own earth. It is shown in its entire length of more than 400 miles from the fine ring-plain Eratosthenes, in the extreme right-hand upper corner of the Plate, which forms the termination of the range to the south, down to the grand promontory of Mount Hadley, more than 15,000 feet in height, in which it ends towards the north. About halfway between the two extremities of the range is the magnificent headland of Mount Huyghens, according to Schroter nearly 21,000 feet in height, the highest summit on the moon with the exception of some of the peaks on the ramparts of the ring-plains of the south polar cap. A third great promontory, Mount Bradley, lies nearly midway between Mount Huyghens and Mount Hadley and reaches a height of about 16,000 ft.

The highland region, of which the Apennines form the north-eastern face, is roughly triangular in shape. By far the loftiest and steepest face is that overlooking the great Mare Imbrium towards the east. The north-western face looks over the Mare Serenitatis, whilst the Sinus Æstuum and the Mare Vaporum bound the region on the south.

The area of the Plate is not one which includesm any of the circular formations so typical of the moon, but some of those which are shown are very striking. Three great ring-plains are seen on the floor of the Mare Imbrium. These, in order of size, are Archimedes, the largest and most eastern, Aristilles, the most northern, and Autolycus, the smallest of the three, just opposite the broad gap which separates the Apennines from the Caucasus. On the opposite side of this opening, and slightly further from it, the celebrated crater Linné is seen as a small white spot on the floor of the Mare Serenitatis. Toward the extreme upper left-hand corner of the Plate, near the border of the same Mare, stands the bright crater Sulpicius Gallus, and amongst the actual highlands of the Apennines are the two craters Conon, just behind Mount Bradley, and Aratus, a little further north towards Mount Hadley. These seven are the most notable circular formations in the Plate. In general, the lunar mountains take the form of rings or polygons, as in the case of these seven objects, and do not make continuous chains as on the earth. To this rule the Apennines constitute the most conspicuous exception, but a detailed examination of them shows that the differences between them and the great terrestrial ranges are numerous and significant.

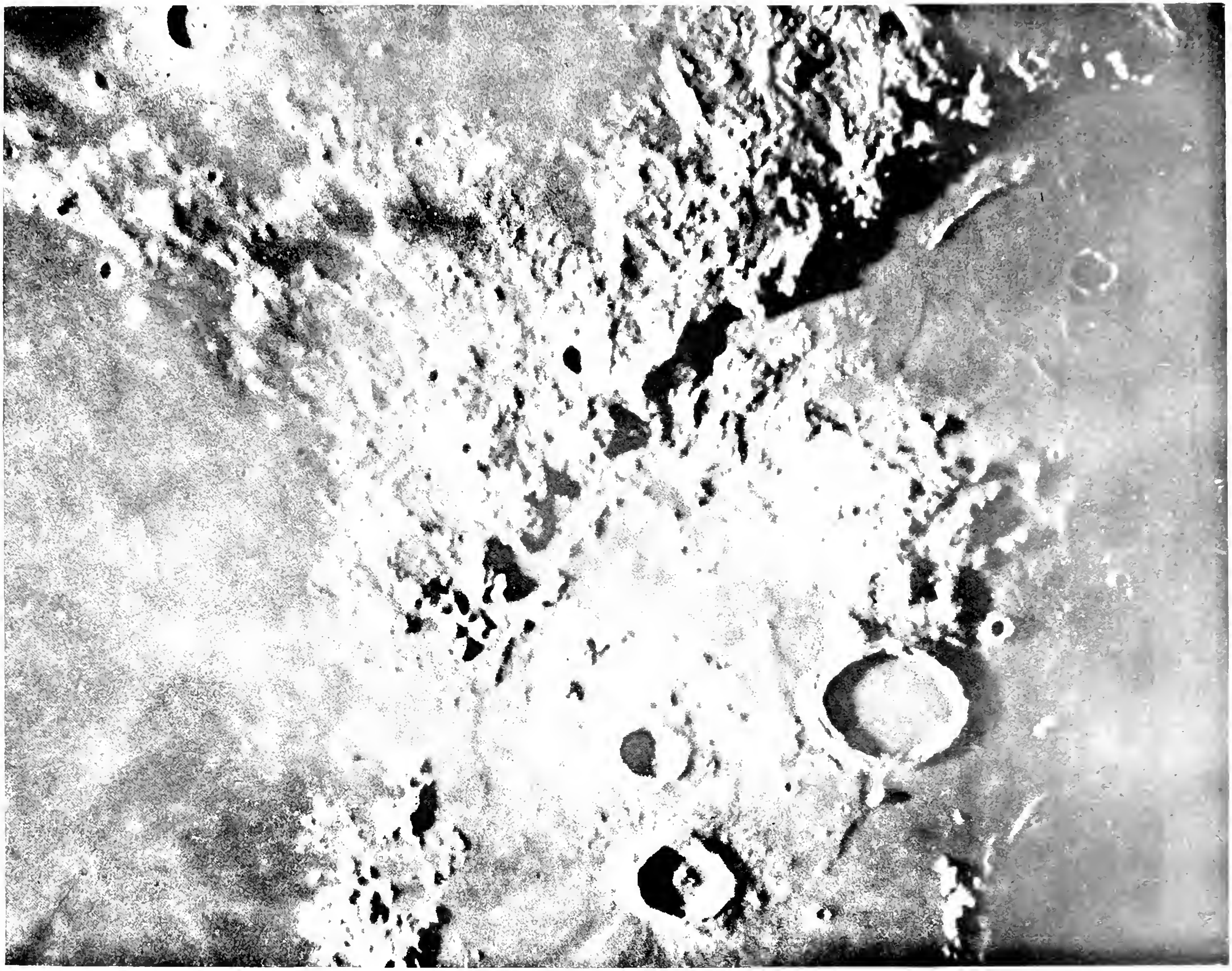
The first feature of the Apennine highlands to claim attention is the nearly triangular form of the area they cover. This is a necessary consequence of the roughly circular form of the great Maria which border them. Wherever we have a number of circular depressions contiguous to each other, the more elevated interstices must necessarily approximate to triangles. And this being the case, it follows that the forms of the highlands have been determined by the Maria and not the reverse. In other words, the highlands existed first and acquired their present outlines through the later formation of the surrounding Maria.



SOUTH.

WEST.

EAST



NORTH.

The Lunar Apennines.

The next feature to be noticed is the general slope of the region. Towards the Mare Imbrium on the east, the face presented by the Apennines is exceedingly bold and steep; towards the Mare Serenitatis and Mare Vaporum on the west and south the highlands sink down gradually.

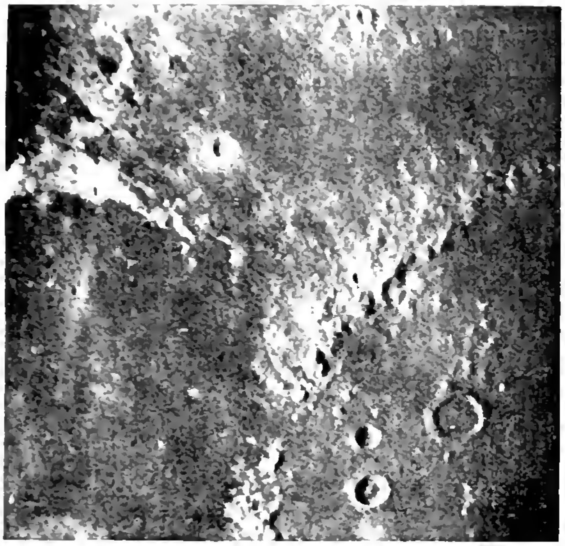


Fig. 1.—Morning.

The result of such a formation upon the earth would be obvious. There would be a deposition of moisture over the whole highland region, either in the form of snow or water, and this moisture would move downwards towards the plains either as streams or glaciers. But it would move with very different speed and different effects upon the two faces. On the steep escarpment facing east

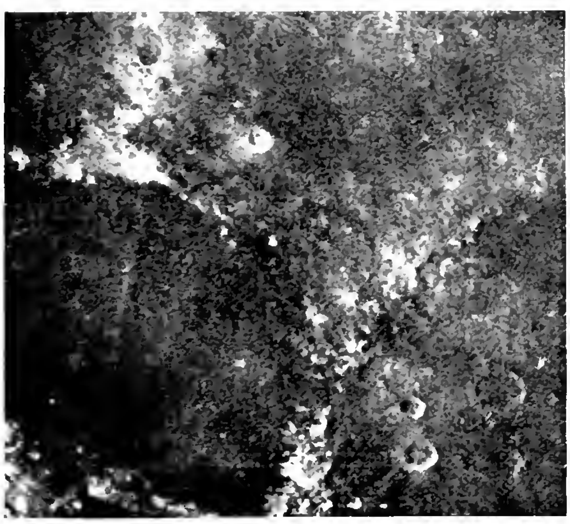


Fig. 2. Forenoon.

neither water, snow, nor ice could rest. The moisture would be quickly thrown off, descending in waterfalls or avalanches down to the plains, and wearing away the cliff face into a great number of narrow gorges or gullies. The *débris* would be deposited at the foot of the cliffs, and the torrents would carve their way some distance into the plain, as a rule in a direction at right angles to the range, smoothing out and covering all irregularities which ran parallel thereto. What we actually see upon the photograph is as unlike this as could well be imagined. The base of the range in the Mare Imbrium is confronted by a line of low hills, wrinkles as it were on the surface of the plain, suggesting by their parallelism to the range

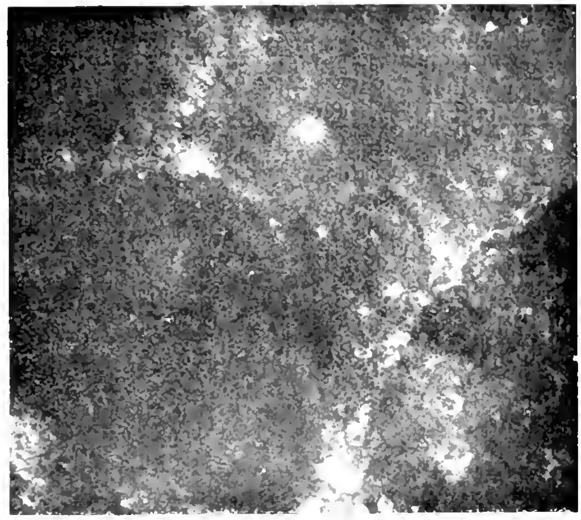


Fig. 3. Noon.

that no effective amount of moisture, either as rain or snow, had been deposited on the eastern slopes of the Apennines since the Mare Imbrium was formed.

But the main drainage of the region would be in the opposite direction, because the chief catchment area would be the broad gentle slope towards the west and south. Here the tendency would be for the moisture, whether it

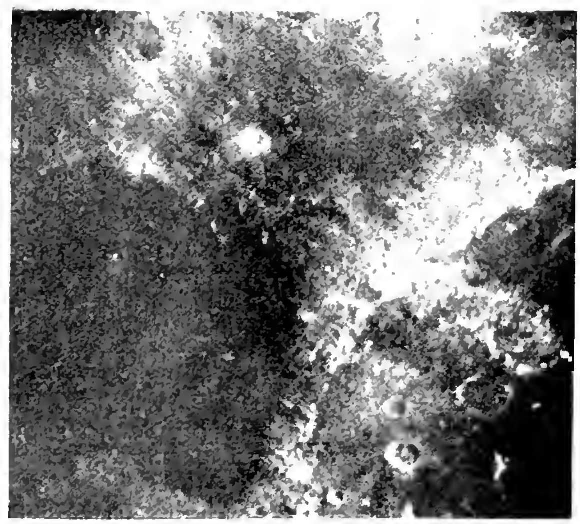


Fig. 4. Afternoon.

was in the form of ice or water, to unite small streams together to form larger ones. Important rivers or glaciers would have their origin in this region, and would work their way downwards excavating broad valleys. The erosive effects, if not so rapid as on the east face, would, from the better presentment to us, be even more conspicuous, and there should be no difficulty in detecting

the deposit of alluvium at the mouths of the great water-courses. We do indeed find valleys and ravines on the western slopes, but these often are so blocked or show so many irregularities of level that they cannot be held to be water channels. If this was their original nature, then the more recent history of the moon must have entirely changed their appearance; we see nothing to remind us of the characteristic arrangement of a drainage area on the earth. More than that, we find in the neighbourhood of Sulpicius Gallus a dark band parallel to the edge of the Mare Serenitatis, as if the Mare was actually deeper here than further out in the plain. Such a channel would have inevitably been filled up by the alluvium washed down by rivers draining the highland district.

It is very instructive to watch the apparent changes produced in any region of the moon by the progress of the lunar day. The five photographs of the regions of the Apennines shown in figs. 1-5 are reproduced from Professor W. H. Pickering's "Photographic Atlas of the Moon," noticed in the last number of "KNOWLEDGE," and will give some idea of the great value of this systematic mode of study which Professor Pickering has

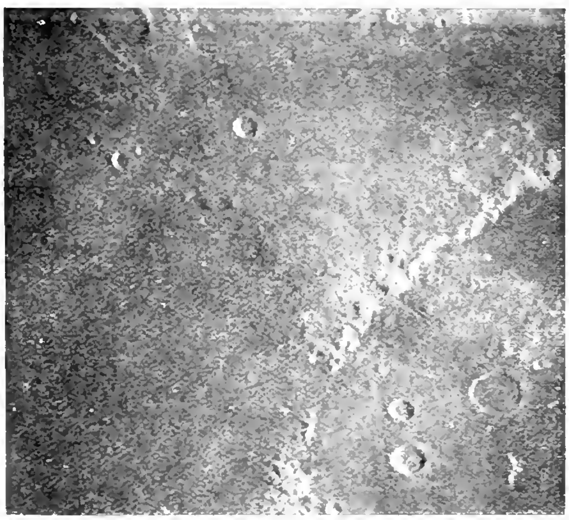


Fig. 5.—Evening.

carried out. It will be seen at once that the change in the lighting produces an immense change in the general appearance of the region. The five photographs we may describe for purposes of reference as showing the district at morning, forenoon, noon, afternoon, and evening; descriptions which are only roughly correct, but which will suffice for reference. It will be seen at once that the appearance of relief vanishes almost entirely at noonday; it increases directly in proportion to the obliqueness of the illumination, and is very marked in the last photograph of the series taken almost at sunset. The two great craters, Archimedes and Eratosthenes, are practically lost at noon. At this time the brightest objects are the glittering peaks of the Apennine range, the rampart of Conon, and the white mantle surrounding Aratus. In early morning and late evening the gradual slopes of the highlands towards the west, and their steep declivities towards the east, are the regions which respectively shine out most conspicuously. But it is the latter which are by far the most brilliant; and, looking at the fifth photograph, there would seem not a little to justify Professor W. H. Pickering's description of them as snow covered. "Many of the higher summits of the Apennines," he writes, "are brilliant with snow, although the sun is just setting upon them, whilst the slopes of the intermediate valleys and of the foothills are dark."

Professor Pickering's interpretation of the brilliancy of the eastern slopes of the Apennines involves several assumptions. He considers that the deposition of snow will vary on the moon according to the elevation of a district and according to its distance from the equator. But it should be borne in mind that elevation on the moon will not be nearly as effective in producing condensation as on the earth. The action of gravity at the lunar surface is but one-sixth of what it is with us. This would have a two-fold effect. Whilst here we reach a region of half the surface pressure at a distance of three and a half miles, on the moon we should have to ascend more than twenty-one miles to obtain the same proportional diminution, whilst the feebleness of gravity would make any upward motion of the atmosphere exceedingly slow. The cooling of an ascending current of air by expansion, here the most efficient cause of condensation, would there be practically inoperative, and the great tenuity of the lunar atmosphere would tend in the same direction. There would scarcely be any perceptible difference in the readiness with which condensation would take place between the plains and the mountain summits.

The comparison of the five pictures, too, does not support the inference that the bright regions are snow-covered. The western gentle slopes are by no means so bright under their best illumination as the steep eastern escarpments are under theirs. Yet it is on the former that we should expect the snow to lie, whilst as they are best lighted by the morning sun, that is to say, just as they emerge from the long lunar night when the snow should be thickest, we should expect them to be far more fully covered, and therefore more brilliant than the steep eastern slopes could be at sunset, after having undergone the continued action of the sun during the whole length of the lunar day. The changes in illumination are indeed just what we might expect from the varying incidence of the solar rays, provided that there was some difference in the reflective power of the different surfaces. And in this case there is no difficulty in pointing out a sufficient cause for the steep slopes being more brilliant than the gentle. Mr. Davison ("KNOWLEDGE," December, 1896, p. 278) pointed out that objects on a slope from, the mere effect of the expansion during the heat of the day and contraction under the cold of night, would steadily creep downwards. There would thus be a very slow but continuous transference of free solid particles from the summits of the mountains towards the plains, uncovering fresh surfaces in the higher regions, and this creeping effect would necessarily be much more rapid on such steep declivities as the eastern face of the Apennines than on the gradual slopes towards the west. If then the very tenuous atmosphere which we may readily believe to exist upon the moon be capable of effecting some slight tarnishing or darkening effect in the course of centuries, or if the deposition of meteoric dust, which must be much the same as upon our earth, slowly coats our satellite with a thin dark veil, we shall find a sufficient explanation for the difference in albedo of the mountain peaks and of the great plains.

This explanation is emphasised by the consideration of a point which Professor Pickering brings forward in proof of the existence of snow deposit. He points out

* I use the terms "east" and "west" throughout this paper, from our point of view. An inhabitant of the moon would, of course, regard the slopes facing the sunset as the western slopes.

that though the central regions of the disc are as "rough and mountainous as that near the pole" they are very much darker. It is hardly the fact that the equatorial regions are as rugged as those of the North Pole, but when we compare the equatorial regions with the polar under the same conditions of foreshortening as well as of illumination the latter have no evident superiority in brightness. It is abundantly clear why the regions near the edge of the disc, whether polar or equatorial, appear the brightest, for it is just here that the darker valleys are concealed from us and that the steep mountain slopes are presented to the fullest advantage.

The question as to whether there are anywhere upon the moon deposits of snow is too large a one to be settled by an appeal to the evidence which even so grand and extensive a formation as the Apennines and their highlands can afford, but so far as they are concerned the verdict would clearly seem to be in the negative. It must always be difficult to distinguish upon the moon between changes which are simply due to changed illumination, and therefore which are apparent only, and changes which are real but are strictly seasonal, for the period of both will be the same. But in this particular region both theory and observation seem to unite in discountenancing the idea of snowfall and in ascribing the apparent changes in the brightness of the Apennine highlands purely to the varying incidence of light on surfaces of different reflective power.

The Canals of Mars.

By W. F. Denning, F.R.A.S.

Recent observations and discussions in reference to the canals of Mars have been very important and will be the means of clearing up doubtful points and putting our knowledge of the planet's surface configuration on a well-assured basis. The fact that many of the spots on Mars represent real features give them a special interest, for the other large planets of our system appear to be too densely involved in atmospheres to exhibit the material conformation of their globes.

Schiaparelli discovered the canaliform aspect of Mars in 1877, and the general correctness of the Italian astronomer's work has been affirmed by many of the leading planetary observers in subsequent years. But the path of the pioneer is difficult and apt to carry one a little astray through its general direction may be accurate enough. Schiaparelli has not been successfully followed in all the details included in his charts of Martian topography, nor has the doubling of many of the canals been corroborated. But apart from the latter peculiarity his delineations form the best working basis for present observers, and carry us far beyond the charts of Green, whose well-executed drawings are marred by the fact that he was over-scrupulous as to the insertion of details not prominently distinguishable.

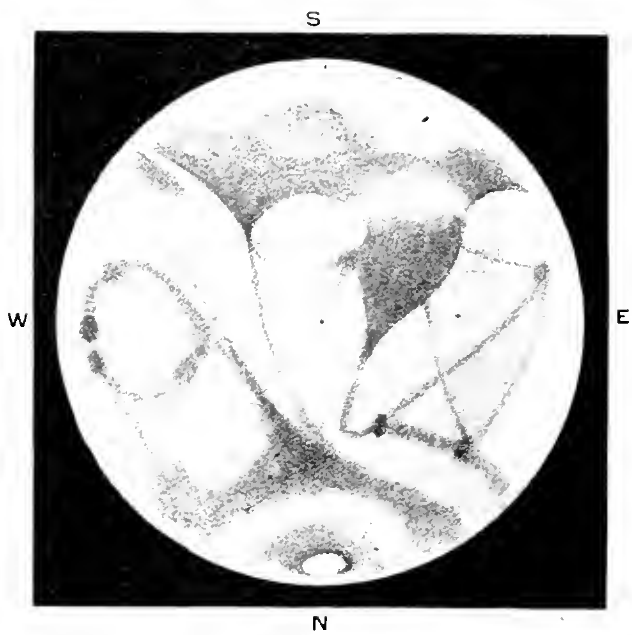
Schiaparelli has no doubt delineated the canals under aspects too straight, hard, and uniform. For the most part the telescope displays them as really faint pencil-like streaks or veins, knotted with darker regions and by no means of equable width or even tone. Though classed under one name and drawn in a uniform way they certainly represent very dissimilar objects.

Some of the canals are due to contrast, and really apply to the boundaries between dusky areas toned a little more deeply than the outlying parts of the ruddy surface.

Others are pretty consistent with their title, being formed of streaks apparently connecting well-known spots, and sometimes meandering over extensive tracks of the surface.

Others again are composed of small irregular condensations, lying approximately in rows and roughly blended together under the aspect of bands in which much detail may be momentarily glimpsed. With ordinary telescopic power, however, their general appearance on the small disc is that of streaks or canals, and the observer figures them as such, being unable to satisfactorily define their structure in detail.

In March, 1903, I began a series of careful observations of Mars with a 10-inch reflector. Favourable weather during the ensuing two months enabled me to examine the planet on 20 nights, when 36 drawings were made. On the first few nights I detected some of the canals under absolutely certain characters. A considerable number of those shown in Schiaparelli's charts were identified, and the result of my scrutiny was to prove the general correctness of his drawings. But I utterly failed to recognize the supposed double canals. To my eye, the lines were invariably single under the highest powers I could effectively apply, and I am bound to conclude that the gemination is not a real feature.



Mars in the Spring of 1903. Longitude, 265°. 10-inch Reflector. Powers, 312 and 375.

During my observations several striking changes were remarked in prominent objects, and these were probably occasioned by atmospheric movements on the surface of the planet. The presence of clouds or obscuring vapours must, however, have affected relatively small regions, for the markings were usually visible from night to night under similar aspects, allowance being made for the variable definition.

The white spots formed striking features, and especially so when on or near the edge of the disc. They appeared to be equally as permanent as the dark markings.

From observed transits of the Syrtis Major, compared with some I obtained with a $4\frac{1}{4}$-in. refractor in February, 1869, I determined the rotation period as 24h. 37m. 22·7s. from 12,135 rotations.

There are really many distinctions in the canal-like markings; some of them are quite broad and diffused shadings, while others are narrow, delicate lines. The

dusky knots (called Oases by Lowell, who claims to have discovered them) were distinctly seen here in 1884, 1886, and other years. In *Nature* for June 3, 1886, I refer to the canals as "linear shadings with evident gradations in tone and irregularities occasioning breaks and condensations here and there."

The ingenious experiments conducted by Messrs. Maunder and Evans (*Monthly Notices*, June, 1903) explain some of the observational results without throwing doubt on the whole canal-system of Mars, as some readers have supposed. Certain of the canals are indeed so conspicuous as to form objective features comparable in point of distinctness and certainty with the dark belts of Jupiter and Saturn.

If we could greatly enhance telescopic power and examine Mars under a sufficiently amplified disc, the canals would probably look very different to those shown in the miniature views supplied in ordinary instruments. We should see them as large blotchy bands of dusky material having no resemblance whatever to sharply-cut waterways. The south equatorial belt of Jupiter consists of a series of spots, and it presents a curious transformation under magnifying powers of 50 and 500. With the former it forms a very dark narrow streak, but with the latter it is broken up into masses of flocculent material covering an extensive track.

If the existence of the Martian canals has been doubted, it is partly the fault of certain observers who have greatly multiplied the real number of these objects, drawn them under unnatural aspects, and elaborated the general appearance of Mars in a manner palpably inconsistent with telescopic revelations.

Mr. Story remarks that "it is time an end should be put to the inquisitorial fashion of refusing credence to scientific discoveries." It is true that certain forms of criticism merely harass and embarrass observers, without effecting any useful purpose. On the other hand, we cannot unreservedly accept everything offered us in the way of observation, real and visionary, objective and subjective. Astronomical history would form a curious medley of fact and fiction (chiefly the latter) if all the supposed "discoveries" of past years were credited and reiterated. Criticism has occasionally proved a wholesome and necessary corrective to results of abnormal and unsupported character.

Conflicting testimony in planetary observation is usually attributed to the differences in telescopes, eyesight, and local atmospheric conditions. But the more potent cause is to be traced to the observers themselves, who differ widely in their discretion, judgment, and interpretations. One man will accept and possibly elaborate extremely delicate features very imperfectly and uncertainly glimpsed. Another will absolutely reject similar appearances. Two things come actively into play and are directly opposed, viz.: (1) The dominating desire to glimpse novelties and gain repute by eclipsing past records; and (2) the necessity of accepting only what is certainly and steadily seen to the exclusion of all doubtful features. On these points observers differ vastly; some of them do not sufficiently realise their responsible positions, and hurriedly make records not justified by telescopic evidence; others are perhaps too punctilious and apt to reject details which are real, though only faintly and fitfully glimpsed.

In judging the quality of results it should be remembered, as a most important factor, that the individual characteristics of the observer play a very prominent part. Some people possess the faculty of seeing objects double. Others will invariably discern novelties where none are visible. Others, again, will detect canals as a necessary feature of a planetary disc. Thus Mercury and Venus have been supposed to display these markings very conspicuously. Phenomenal vision will not explain the anomalies alluded to. Objective markings are capable of being corroborated without any difficulty. The spots on Saturn were distinguished by many observers shortly after their discovery. There is no reason why canals should prominently diversify Mercury and Venus as seen by one observer, while as viewed by others the discs of those planets appear, under the best circumstances, absolutely free from such markings. On many occasions during the last few years the beautifully defined disc of Venus has been examined by the writer, but not the vestige of a canal has ever revealed itself; yet at the Lowell Observatory, Mexico, "the markings are perfectly distinct and unmistakable, invariably visible, and nothing but a very unsteady air can obliterate them" (*Monthly Notices*, Vol. LVII. 1896-7, pp. 149 and 402).

Flammarion was probably quite correct in his expression ("KNOWLEDGE," November, 1897) that "the maps of Venus made up to the present time are illusions."

But our present concern is with Mars. The story of his canal-like markings is a true one, though it has been occasionally exaggerated, and it will survive all the opposition levelled against it by sceptics and incapable observers. The northern hemisphere of the planet seems replete with dusky streaks forming the canals. They may not indicate water courses, and their real aspect may be something very dissimilar to that displayed in ordinary telescopes, but with the means employed observers are correct in representing many of them as lines and bands of shading connecting the more bulky spots.

The Spinthariscope.

THE ingenious instrument to which Sir William Crookes gave the name of the Spinthariscope, and which he devised to show the torrent of rays or the fragments of atoms which are continually being shot out from radium, is now a familiar object to most scientific people. The instrument as is well known consists of a little screen of zinc sulphide or blende, at a slight distance from which a fragment of radium bromide is situated on a pointer. As the emanations from the radium strike the screen they produce an effect similar to that which a bullet produces when it strikes a target, and by means of a magnifying glass the phenomenon is rendered clearly visible. The instrument is now made by Messrs. A. C. Cossor, and one of them which has been sent to us shows the scintillation with remarkable clearness and vividness. It is, perhaps, the most ingenious, and certainly the most lasting, scientific toy that ever has been produced.

SOME time ago in a lecture to the Camera Club, Mr. Duncan destroyed the poetic belief relating to the nautilus, which is expressed in Pope's lines

"Learn of the little nautilus to sail,
Spread thine oar and catch the driving gale"—

by remarking that the little sails which the nautilus was popularly and poetically supposed to spread were, in fact, never raised at all, but were always tightly clasped about the shell. In a paper contributed to the *Natural History Magazine*, Captain Barrett Hamilton disturbs an idea relating to the wings of the flying fish that is at least equally wide-spread. In the true flying fish Captain Hamilton says the "wings" are never moved as organs of flight. They may vibrate or quiver under the action of air currents, or a shifting a little of their inclination by the fish, but the whole motive power is supplied by the powerful tail. The wings are a parachute to augment the action of this propeller. Their motions are in no way comparable to those of the wings of a bird.

The Face of the Sky for April.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 5.38, and sets at 6.31; on the 30th he rises at 4.35, and sets at 7.16.

The equation of time is negligible on the 15th and 16th, hence these are convenient days for the adjustment of sun dials or for laying down a meridian line to a close approximation.

Sunspots are of frequent occurrence; their positions may be located by the use of the following table:

Date.	Axis inclined to W. from N. point.	Centre of disc, S. of Sun's equator.
April 5 ..	26° 25′	6° 12′
,, 15 ..	26° 14′	5° 27′
,, 25 ..	25° 14′	4° 34′

THE MOON:

Date.	Phases.	H. M.
April 7 ..	Last Quarter	5 43 p.m.
,, 15 ..	● New Moon	9 53 p.m.
,, 23 ..	First Quarter	4 5 a.m.
,, 29 ..	Full Moon	10 30 p.m.
April 10 ..	Apogee	9 30 p.m.
,, 26 ..	Perigee	6 30 p.m.

Occultations.

The following are the principal occultations visible at Greenwich at convenient times:

Date.	Star's Name.	Magnitude.	Disappearance		Reappearance		Moon's Age.
			Mean Time.	Angle from N. point.	Mean Time.	Angle from N. point.	d. h.
April 2 ..	49 Librae ..	5·6	11 4 p.m.	11	12.9 a.m.	297	17 17
,, 4 ..	B.A.C. 3395 ..	5·9	9 25 p.m.	118	10 33 p.m.	284	9 0
,, 25 ..	ω Virginis ..	5·3	10.6 p.m.	103	11.18 p.m.	303	13 0
,, 29 ..	B.A.C. 4528 ..	6·0	9 40 p.m.	75	10.37 p.m.	327	14 0

THE PLANETS.—Mercury should be looked for in the N.W. shortly after Sunset from the 15th to the end of the month. About this time the planet is in the most favourable position for observation for the present year, and sets about two hours after the Sun. On the 21st he arrives at greatest easterly elongation of 20° 11′, and although this is not so large as the autumnal elongation, the greater inclination of the ecliptic to the horizon at this time puts the planet into a much more favourable position for observation.

The diameter of the disc is 8″·4.

Venus cannot readily be observed, as she only rises about half an hour in advance of the Sun, and is thus lost in the bright dawn.

Mars is practically unobservable, as he sets before it is really dark.

Jupiter was in conjunction with the Sun towards the end of last month, and is therefore too close to the Sun for observation.

Saturn is a morning star, rising at 3.15 a.m. near the middle of the month; he is situated in Capricornus, and consequently low down in the sky.

Uranus rises on the 1st about 1.30 a.m., and on the 30th at 11.30 p.m.; throughout the month the planet is close to μ Sagittarii, being only six minutes west and having approximately the same declination as the star.

Neptune is getting more to the west, and sets about 1.30 p.m. near the middle of the month. He is describing a retrograde path towards η Geminorum; his position with respect to that star may be seen on reference to the chart given in the January number.

METEOR SHOWERS:

Date.	Radiant R.A.	Radiant Dec.	Name.	Characteristics.
	h. m.			
Apr. 17–May 1	16 0	+ 47	τ Herculids	Small, short
,, 20–21	17 20	+ 36	π Herculids	Swift, bl. white.
,, 20–22	18 1	+ 33	**Lyrid Shower**	Swift
,, 30	19 24	+ 59	ο Draconids	Rather slow.

THE STARS.—About the middle of the month at 9 p.m. the positions of the principal constellations are as follows:

ZENITH . . Ursa Major.

NORTH . . *Polaris*; to the right, Ursa Minor and Draco; to the left, Cassiopeia and Perseus; below, Cepheus and Cygnus.

SOUTH . . Leo and Hydra; to the south east, Virgo; to the south-west, Gemini (high up), *Procyon*, and *Sirius* (setting).

WEST . . Taurus, Pleiades, and Orion, all rather low down.

EAST . . *Arcturus*, Corona, and Hercules; to the north-east, *Vega* rising.

Minima of Algol may be observed on the 7th at 10.38 p.m., 10th at 7.27 p.m., and 30th at 9.10 p.m.

TELESCOPIC OBJECTS:—

Double Stars.—γ Virginis, XII.^{h} 37^{m}, S. 0° 54′, mags. 3, 3; separation 5″·7. Binary system; both components are yellow, though one is of a deeper hue than the other. An eyepiece of a power of 30 or 40 is required on a 3-in. to effect separation.

π Boötis, XIV.^{h} 36^{m}, N. 16° 53′, mags. 4, 6; separation 6″. Requires a power of about 10.

ε Boötis, XIV.^{h} 41^{m}, N. 27° 30′, mags. 3, 6½; separation 2″·7. Very pretty double, with good colour contrast, the brighter component being yellow, the other blue green.

ξ Boötis, XIV.^{h} 47^{m}, N. 19° 31′, mags. 5, 7; separation, 2″·4. Binary; one component being orange, the other purple.

Clusters:—M 3 (*Canes Venatici*), XIII.^{h} 38^{m}, N. 28° 48′. This object, though really a globular cluster of myriads of small stars, appears more like a nebula in small telescopes. It is situated between Cor Caroli and Arcturus, but rather nearer the latter.

NOTES

ASTRONOMICAL.

M. Janssen's Photographic Atlas of the Sun.

Some twenty-eight years ago, M. Janssen set on foot a photographic study of the solar surface at the Meudon Observatory, of a somewhat special kind. His object was to obtain the greatest possible sharpness of definition, and for this purpose he had an objective constructed for him by Prazmowski which brought the rays near the G line of the Fraunhofer spectrum, and practically these alone, to a well-defined focus. In conjunction with this instrument he used collodion plates, sensitised by bromo-iodide, in which the iodide predominated, with a small range of sensitiveness which corresponded to the region of the spectrum for which the object glass had been constructed. The photographs were therefore obtained almost by monochromatic light, and were exceedingly sharp. The objective employed had an aperture of 0·135 metres and focal length of 2 metres, a secondary magnifier enlarging the image of the sun in the telescope some 15 diameters. Some of the most characteristic and best defined from the store of over 6000 negatives which have now been accumulated at the Meudon Observatory have been reproduced, enlarged four times from the originals, in a superb atlas, recently published by M. Janssen. These plates, 30 in number, and 21 inches by 18 in size, are on a scale of about 4 feet to the solar diameter, and show the intimate structure of the solar surface with a minuteness and detail never seen in any previous publication; the minute granulation of the surface and the different forms of the réseau photosphérique being most admirably illustrated.

Some Peculiarities of Comets' Tails.

In an article in "Popular Astronomy," illustrated by a number of beautiful photographs, Professor Barnard draws attention to some peculiarities apparent in the photographs of some recent comets which do not seem to be sufficiently explained by the well-known theory of Professor Bredikhine of the repulsive action exercised by the sun upon the cometary nucleus. The comets specially remarked upon are those of Swift, 1902; Brooks, 1893; and Borrelly, 1903. The remarkable way in which the tail of Brooks' Comet was contorted and broken on October 22, 1893, seems to clearly indicate that it had encountered some resisting or disturbing medium. The case of Borrelly's Comet was not less remarkable, but of a different kind. Here a tail, itself apparently uninjured, was seen at a distance from the head. In this case there seems to have been a slight but sudden change in the direction of the emission of matter from the comet's head, thus cutting off the supply from the first formed tail. The detached tail, however, showed no clear evidence of acceleration in its motion, and this would suggest that the sun had little to do with its flight into space.

Radial Velocities of Twenty Stars of the Orion Type.

Amongst the Decennial Publications of the University of Chicago is a Memoir by Messrs. Edwin B. Frost and Walter S. Adams upon the motions in the line of sight of twenty stars of the Orion type. The photographs of these spectra were obtained with the Bruce spectrograph attached to the great refractor of the Yerkes Observatory. The comparison spectrum was always that of titanium, and sometimes, in addition, iron or chromium, or else a helium tube which also gave the hydrogen lines. The absolute velocities of the twenty stars observed was evidently very small, and when corrected for the solar motion gave 7 kilometres a second as the mean of the twenty radial velocities. The proper motions of these twenty stars (not their *real* radial velocities, as Professor Frost's memoir has been curiously misread) are exceedingly small; the mean for nineteen of them only being 0″015 on a great circle, which is much smaller than for solar stars of corresponding brightness, and indicates that the Orion type stars are, as a class, very remote. A classification of thirty-one stars of the type is given at the end of the paper, according to the character of the lines of helium, silicon, nitrogen, and oxygen in their spectra.

The Stars of Secchi's Fourth Type.

Another of the Decennial Publications is a Memoir by Professor Hale and Messrs. Ellerman and Parkhurst on the spectra of stars of the type of 152 Schjellerup, the Fourth Type of Secchi's classification. The spectra of eight stars were examined, and some most important conclusions reached. A great number of bright and dark lines were detected over and above the violet flutings of cyanogen, and the flutings of the Swan spectrum. Of the dark lines, a large number were measured, showing the presence of carbon, hydrogen, magnesium, sodium, iron, calcium, and other metals recognised in the sun. The carbon and metallic vapours appear to be very dense, and to lie immediately above the photosphere; above these dense vapours are others giving rise to the bright lines, of which about 200 are present. None of these could be identified with certainty, but a few may possibly correspond to the bright lines of the Wolf-Rayet stars, which the Fourth Type spectra resemble in some other characteristics. Many lines widened in sunspots are represented by strong dark lines, suggesting that these stars may be largely covered by spots akin to those of our sun. Some twenty per cent. of the Type appear to be variable, exceeding the proportion observed in the case of Third Type stars. Professor Hale suggests that the Third and Fourth Types should be classed together as probably having developed from stars like the sun through loss of heat by radiation.

ZOOLOGICAL.

The Colours of Lobsters and Prawns.

Experiments undertaken many years ago were believed to demonstrate that the colouring of crustacea was largely, if not entirely, of a protective nature. For instance, when prawns or young lobsters were placed, in broad daylight, on black dishes, the pigment-bearing bodies, or "chromatophores," in their integument were observed to expand, with the result that a dark type of coloration in harmony with the tone of the surroundings was produced. Conversely, when the creatures were placed on a white dish, the pigment bodies contracted, with the resulting production of a pale tone of coloration, harmonising so far as possible with the background. Moreover, if the crustaceans were deprived of sight, no such adjustment of colouring occurred, although it took place immediately that vision was restored.

From these and other experiments, it has become the current opinion that the pigments of crustaceans are superficial and sporadic in distribution, that they are confined to single cells—chromatophores—of the epidermal or connective tissues, and that they are either protective in function or form a waste functionless product of development.

Recently, the subject has been taken up anew by Messrs. Keeble and Gamble, the results of whose investigations appear in the *Philosophical Transactions* of the Royal Society. While fully recognising the paramount influence of background on the colours of crustaceans, the authors find themselves compelled to adopt an attitude of reserve and indecision in regard to most of the foregoing points. They state, for instance, that even the protective function of colour is not definitely determined by experiment; while pigment in crustaceans may be deep-seated, and may also occur in complex organs not functionally related to one another. Further investigation is necessary before anything definite can be predicated as to colour-function in these creatures.

An English Spiral-Sawed Shark.

For many years certain remarkable bodies, somewhat resembling a large watch-spring armed on the convex side with teeth, have been known from the Carboniferous and Permian rocks of various countries; the most nearly complete coming from Russia. There has, however, been much uncertainty as to their true nature. At first they were supposed to be the fin-spines of fishes; but the aforesaid Russian specimens clearly showed that they belong to the front of the jaws of sharks, and that they are true teeth, which are mounted upon their supporting base in such a manner as to form a spiral. Hence the name of spiral-sawed sharks for the group to which they pertained. Hitherto this group has been known only from North America, Australia, Japan, and Russia; the type genus being *Edestus*. Recently, however, Mr. E. T. Newton, in the *Quarterly Journal of the Geological Society*, has described part of the "saw" of one of these remarkable sharks from a marine band in the Coal Measures of Nettlebank, North Staffordshire, giving the name of *Edestus triserratus* to the species it represents.

The Medusa of Lake Tanganyika.

The discovery of the Freshwater Medusa, *Limnocnida Tanganyikæ*, in Lake Victoria, which was announced to the Zoological Society of London at their meeting in December last by Professor Ray Lankester, is an event of some scientific importance, as this remarkable form had been previously believed to be entirely restricted to Lake Tanganyika, and to be one of the most significant pieces of evidence in favour of Mr. Moore's theory of Lake Tanganyika having been formerly connected with the ocean. When Professor Lankester exhibited his specimens he was not quite certain that they had been obtained in Lake Victoria, but we believe that further information recently received leaves absolutely no doubt on this point, the specimens having been taken in Kavirondo Bay by Mr. Hobley. Moreover, confirmation on this subject has been furnished by a French Naturalist, M. Ch. Gravier who obtained nine examples of this Medusa in the Bay of Kavirondo on the 10th of September last year, as has been announced by M. Perrier to the French Academy of Sciences. M. Perrier agrees with Professor Lankester in considering the Medusa from Lake Victoria to be identical with that of Lake Tanganyika, and of this we believe there is no doubt.

Some people have thought that this remarkable discovery is rather a serious blow to the theory of the "halolimnic" nature of Lake Tanganyika, but Mr. Moore does not seem to be at all disconcerted by it. In a letter to *Nature* (of February 18th) he maintains that so far from this fresh piece of knowledge "being in any way antagonistic to the view in question," the existence of the Medusa in other Lakes is "exactly what one would anticipate, supposing the halolimnic theory to be correct." Mr. Moore thinks that it may be explained in two ways. It is quite possible, he believes, that the Medusa may be a recent importation into Lake Victoria from Lake Tanganyika, caused by the opening of new trade-routes between the Lakes, and the carriage of water in gourds and other vessels from one lake to another. If this shall be found not to have been the case, then future researches will probably result in the discovery of the rest of the "halolimnic fauna," or part of it, in Lake Victoria. This, it is maintained by Mr. Moore, would confirm the view that he has already put forward, "that the ancient sea from which the halolimnic relics sprang spread much further towards the east than was at first supposed."

To settle this and many other interesting problems it is certainly advisable that a much more accurate investigation of the Fauna and Flora of Lake Victoria should be made than has yet taken place. Lake Tanganyika seems to have more attention paid to it as yet than Lake Victoria.

The Palolo Worm.

In a recent issue of our contemporary, the *American Naturalist*, Mr. W. McM. Woodworth gives an interesting account of the palolo worm of Samoa and Fiji. For more than half a century the appearance of swarms of these worms, apparently always just before the full moon, in October and November, has been familiar, and it has also been known that the worms forming these swarms are always imperfect. It is now ascertained that these palolo are the slender posterior generative portion of the annelid known as *Eunice viridis*, which at the swarming season becomes detached and free-swimming. This portion is very much longer than the proper body of the creature, which is, however, much stouter. The complete worm dwells in coral-reefs, into which it burrows; and, curiously enough, its existence there was quite unknown to the Samoans, to whom the demonstration of its presence by Mr. Woodworth came as a revelation. The worm only attains its full dimensions shortly before the swarming season.

A Precious Product.

According to a writer in the February number of the *Zoologist*, a lump of ambergris, weighing about $4\frac{1}{2}$ lbs., was taken from the intestines of a male sperm-whale killed last June between Iceland and Norway, in about the latitude of Trondhjem; a very unusual resort, by the way, for cetaceans of this species. Ambergris, which is very largely used in perfumery, is solely a product of the sperm-whale, and appears to be a kind of biliary calculus. It generally contains a number of the horny beaks of the cuttle-fishes and squids, upon which these whales chiefly feed. Its market price is subject to considerable variation, but from £3 to £4 per ounce is the usual average for samples of good quality. Mr. T. Southwell, the writer referred to, states, on the authority of a correspondent in the sperm-oil trade, that in 1898 a merchant in Mincing Lane was the fortunate owner of a lump of ambergris weighing 270 lbs., which was sold in Paris for about 85s. per ounce, or £18,360.

African Insects.

Descriptions and illustrations of the entomological fauna of Tropical Africa are in course of publication in the *Annales* of the Congo Museum, issued at Brussels. In one of the two latest parts, Mr. A. Lameere describes the longicorn beetles of the sub-family *Prioninæ*, while in the other Mr. H. Schouteden writes on certain groups of flower-bugs. Both memoirs are illustrated by coloured plates remarkable for their beauty of execution.

Papers Read.

At a recent meeting of the Royal Society a communication was read on the pharmacology of Indian cobra-venom, based on experiments made by Captain R. H. Elliot, of the Indian Medical Service. On the 3rd of March, at the Linnean Society, Dr. J. G. de Man described certain species of the crustacean genus *Palæmon* from Tahiti, Shanghai, New Guinea, and West Africa. The papers read at the meeting of the Zoological Society, held on March 1st, included one by Mr. R. T. Leiper on *Vagina incola*, a new genus and species of the *Proporidæ*, with a note on the classification of the group; and a second, by Dr. Einar Lönnberg, of Stockholm, on two specimens of hybrid grouse of which the exact parentage is known. The papers read at the meeting of the same Society on March 15 comprised one by Mr. F. E. Beddard on the anatomy of lizards, one by Mr. Lydekker on certain points in connection with the skull and colouring of the extinct quagga; a second by the same author on the distinctive features of the Asiatic wild asses, respectively known as the Chigetai and the Kiang; one by Mr. R. J. Pocock on a new African monkey, and one by Mr. P. J. Lathy on additions to the list of Dominican butterflies (*Rhopalocera*).

Certain interesting specimens were exhibited at the Zoological Society's meeting on March 1. In the first place, Dr. Gunther directed attention to hybrids between Reeves's pheasant and the silver pheasant. Next, Mr. Thomas exhibited the skull of a large buffalo killed by Colonel Delmé-Radcliffe in S.W. Uganda, which was believed to indicate a distinct local race of *Bos caffer*. The same gentleman also displayed a new species of fruit-bat from Fernando Po, remarkable for its small bodily size. Thirdly, Mr. J. G. Millard exhibited a collection of skins in illustration of the life-history of the grey seal, whose geographical distribution was discussed. A few other minor exhibits were likewise made.

Corrigenda.

Owing to an unfortunate oversight, the author of the article on the Ancestry of the Camel and writer of Zoological Notes in the March Number had no opportunity of revising the proofs; the following corrections are therefore necessary.

P. 25,	1st Col.,	line 17	from bottom,	for *gazella*	read *gazelle.*
,, ,,	2nd ,,	,, 20	,, top	,, *are*	,, *is*
,, 26,	,, ,,	,, 10	,, ,,	,, *Linta*	,, *Unta.*
,, 27,	1st ,,	,, 26	,, ,,	,, *Procamelas*	,, *Procamelus.*
,, ,,	,, ,,	,, 4	,, bottom	,, *Phauchenia*	,, *Phauchenia.*
,, ,,	2nd ,,	,, 19	,, ,,	,, *Camelas*	,, *Camelus.*
,, 28,	1st ,,	,, 28	,, top	,, *Alticamelas*	,, *Alticamelus.*
,, ,,	,, ,,	,, 25	,, ,,	,, *Procamelas*	,, *Procamelus.*
,, ,,	,, ,,	,, 8	,, bottom	,, *Paracamelas*	,, *Paracamelus.*
,, 42,	,, ,,	,, 33	,, top	,, *Lada*	,, *Lado.*
,, ,,	2nd ,,	1st line		,, *gulo*	,, *Gulo*
,, ,,	,, ,,	line 35	,, bottom	,, *Malayensis*	,, *Malayenses.*
,, ,,	,, ,,	,, 24	,, ,,	,, *Parachiromys*	,, *Metachiromys.*
,, ,,	,, ,,	,, 12	,, ,,	,, *Soemmeringi*	,, *sœmmerringi.*

BOTANICAL.

The rare occurrence of stamens developing inside the ovary has been recently met with in a Caryophyllaceous plant, *Melandryum rubrum*, and is made the subject of a paper by Professor F. Buchenau in the *Berichte der Deutschen Botanischen Gesellschaft*, XXI. The material was collected in the neighbourhood of Marburg, Germany, having first attracted attention on account of the absence of petals. A closer examination revealed great irregularity in the structure of the ovary and in the number of the stigmas, and on making a section of the former it was found to contain six to nine, sometimes ten, well-developed stamens arising from its base, the central placenta, with the ovules, being altogether wanting. Dr. M. T. Masters, in his *Vegetable Teratology*, refers to a Myrtaceous plant, *Bæckea diosmæfolia*, in which a similar abnormality was found. The ovary contained no ovules, but numerous stamens, in various stages of development, were attached to the inside walls. In other respects the flower appeared to be quite normal.

The standard work on the flora of South Africa is, of course, the *Flora Capensis*, which was begun by Harvey and Sonder, and is being continued under the editorship of Sir W. T. Thiselton-Dyer. This work, of which a new part has just been issued, gives full descriptions, with synonomy and localities, of all the known flowering plants of Africa south of the tropics, and is necessarily bulky and expensive. Professor Henslow's *South African Flowering Plants*, lately published by Longmans, Green, and Co., will be welcomed by those who seek a handy inexpensive work on the South African flora, but who do not require the fulness of the *Flora Capensis*.

The very imperfectly known flora of Siam is being investigated by Mr. F. N. Williams, who has commenced an enumeration of the plants of this country in the last number of the *Bulletin de l'Herbier Boissier*. His work is based on the material in the Kew Herbarium. Collectors have paid very scanty attention to this flora, and several sets of plants, said to be from Siam, are shown to be from localities outside its boundaries, and cannot, therefore, be included in his enumeration. Some preliminary remarks on the flora were made by the same author in the *Journal of Botany* of September, 1903, where he mentions the interesting fact that the well-known commercial product, Siam benzoin, is obtained not from Siam but from a locality in the Lao province of French Indo-China.

PHYSICAL.

Chlorophane.

Chlorophane is the name given to those varieties of Fluorite (Fluorspar Calcium Fluoride), which possess to a noticeable extent the property of "thermo-luminosity," that is to say, of spontaneously emitting light when heated. The temperature at which this phenomenon takes place is not the same in all cases, but varies with different varieties of the mineral—the heat required being generally between 300 and 400 C. On first heating little or no light is emitted, until what may be called the "critical temperature" is reached, when the Chlorophane glows brightly and continues to glow for some hours after cooling to ordinary temperature, but more feebly. The colour of the light varies, blue and green predominating. Hagenbach found that the spectrum of phosphorescent Fluorite consisted of only nine bands, four blue, two green, two yellow, and one orange. As the relative intensity of these bands is continually changing, it is easy to understand the different colours presented by different varieties of this mineral. The pure white Fluorite does not possess the properties of Chlorophane, apparently the presence of some other salt or impurity is necessary, as in the case of phosphorescent Calcium Sulphide.

* * *

Chlorophane and Radium.

Madame Curie states (*Chemical News*, Vol. LXXXVIII., No. 2293, p. 223), that: "Fluorite when heated undergoes a change, which is accompanied by the emission of light. If the Fluorite is afterwards subjected to the action of Radium an inverse change occurs, which is also accompanied by an emission of light." This being so, what effect would be produced by first acting upon the Fluorite with Radium, and then applying heat? The following experiment was devised for the purpose of ascertaining this. A small crystal of Chlorophane was exposed for six hours at a distance of two millimetres from 10 milligrams of Radium Nitrate (Giesel's preparation) in such a manner that only the β and γ rays acted upon it. The initial fluorescence excited under these conditions was fairly bright, and persisted after removal but slightly diminished in intensity, and when kept at uniform temperature fell to half value in two to three days, dying down to negligible quantity in six to seven days. The changes in thermoluminosity were very marked, a very slight rise in temperature, such as that produced by placing the crystal in the palm of the hand, sufficing to increase the luminosity about 100 per cent. This increase is at the expense of the duration of retained fluorescence. The "Alpha" rays of Radium are without appreciable effect on Fluorite. Careful observations made with a Bismuth plate covered with a deposit of Markwald's Radio-tellurium (Polonium?) of sufficient radio-activity to cause a piece of Willemite to glow brightly when in close contact, gave only negative results. It would be of great interest to know the exact nature of the change occurring in the chlorophane, whether it is of a chemical or physical kind.—*Ernest L. Armbrecht, M.P.S.*

[N.B.—The writer also finds that the above properties are not confined to Chlorophane, but are also shown by Kunzite, with which very pretty experiments may be made on above lines.]

* * *

Wireless Telegraphy Experiments between Germany and Sweden.

The Berlin Gesellschaft für Drahtlose Telegraphie some time ago installed two wireless telegraphy stations on the Norwegian Loffoden Islands, the two points chosen being 50 km. distant and separated by high continuous rocky masses, so as to oppose serious obstacles to the passage of the electric wave. These stations were designed for dry cell operation, in order to ascertain whether communication over distances as high as 50 km. would be possible with such small amounts of electric energy. This, however, was found not to be the case as the primary energy of a limited number of dry cells proved insufficient, a consumption of about 200 watts being necessary to overcome the obstacles on the passage of the electric waves.

The experiments between Germany and Sweden, as contemplated for some time past, were begun on December 16th, when wireless telegraphy communication was secured between Oberschönweide, near Berlin, and Karlskrona, a Swedish naval station, over a distance as high as 450 km. The results so far obtained are said to be quite satisfactory.

The "Telefunken" system used is a combination of the Braun and Slaby-Arco schemes which, we learn, is being frequently used with the Swedish Navy.

* * *

The National Physical Laboratory.

One of the prominent even tsof the past month was the annual visitation and inspection of the important standardizing and testing laboratory at Bushey House, Teddington. Erstwhile a Royal domicile, the mansion and adjacent buildings are now

devoted to experimental work designed to promote the joint interests of the nation's manufacturing industries in the conduct of which applied knowledge is requisite and theoretical inquiry of a scientific character. Probably few of the general public who visit Bushey Park in such numbers are aware of the proximity of the National Physical Laboratory, still less of its aims, although it is a public institution maintained by means of the taxpayers' money. Here, however, a great work is unobtrusively going forward, whose benefits spread themselves far and wide. Many and varied are the investigations pursued. In electricity, for example, is one on the effect of temperature on the insulating properties of materials used in dynamos, motors, and transformers; in thermometry a research on the specific heat of iron at high temperatures; in metrology, the standardization of the steel yard and nickel metre; and in metallurgy a series of tests on nickel steel. Then, in the department of engineering, experts say that the inquiries in hand are eminently useful to a producing country such as England is, and hopes to remain, despite her foreign competition. Comprised in electrotechnics are tests on electrical instruments, ammeters, wattmeters, voltmeters, and other indispensable adjuncts to the needs of industry. Again, in chemistry, optics, and photometry, the record of investigation bears the same tendency.

The laboratory is, of course, a young organisation as yet, but its operations are ramifying in all directions under the able guidance of Mr. R. T. Glazebrook, F.R.S. But, as Lord Rayleigh, the Chairman of the General Board, pointed out the other day, unless adequate funds are provided to meet the national purposes of the foundation the institution must fail in accomplishment, and a starved laboratory would probably prove a worse evil than none at all. Besides, it should be borne in mind that Paris and Washington have recently followed the example of London in initiating standardizing establishments intended to help national industries each, too, is subsidised in a far more liberal way than in our own case. The necessity for making better provision for the needs of the laboratory has lately engaged the earnest attention of the Executive Committee, and representations have been made to His Majesty's Treasury on the subject. A detailed scheme for the future organization and development of the institution has been drawn up and submitted. This, if approved, will entail a revision of the existing Parliamentary grant-in-aid, but in view of the special functions of the laboratory, and the sphere of usefulness that lies before it, strong hopes are entertained of a favourable issue to the appeal.

CORRESPONDENCE.

A Novel Electric Traction System.

To the Editors of "Knowledge."

Sirs,—The scheme described under the above heading in your March issue, taken from the *Electrotechnischer Anzeiger*, presents such curious features that one is inclined to doubt whether it has been put forward seriously. To use electrically-heated steam-engines in preference to electric motors would appear, at any rate at first sight, as an absurdity, as the following considerations will show.

It may be safely assumed that the internal thermal efficiency of a steam locomotive does not exceed 10 per cent., *i.e.*, only 10 per cent. of the thermal energy carried by the steam from the boilers into the cylinders is converted into work on the piston. So that, accepting 90 per cent. as the efficiency of the electric heaters, and assuming the mechanical efficiency of the engines to be as high as 90 per cent., it follows that of the electrical energy supplied to the boiler all that is available for propulsive power is 90 per cent. of 10 per cent. of 90 per cent., *i.e.*, about 8 per cent. Against this the ordinary electric locomotive would have, as stated in the article, an over-all efficiency of 60 to 70 per cent., or even more.

Now although the actual energy for a water-power installation in a sense costs nothing, the plant to develop it is very costly; and it may be safely predicted that it would not pay to use a generating plant and transmission system eight or nine times too large to save scrapping the steam locomotives.

This very large ratio against the electro-thermal system would, it is true, be reduced by the fact that every locomotive would to some extent act as an equaliser of the demand on the power-houses, reducing the excess plant that would have to be installed; but the larger system worked from one power house, the less this advantage would become; and in any case the excess of power required by the electro-thermal system would be enormous.

Even if under any conceivable conditions such a system might prove advantageous, it is certain that the figures put forward to justify the proposal are entirely erroneous; and this confirms one's doubts as to the scheme having emanated from any authoritative quarter.

The first point to be noted is that it is proposed to raise the temperature of the water from 10° to 190° C., requiring 180 calories per kg.; but 190° C. is said to correspond to a steam pressure of 50 kg. per sq. cm. As a matter of fact, 190° C. (= 374° F.) corresponds to saturated steam at about 170 lbs. per square inch (above atmosphere), whilst 50 kg. per sq. cm. is equivalent to 710 lbs. per square inch. However, as pressure is not referred to further by the writer this discrepancy does not matter much.

But next it is said that to raise 4000 litres of water through 180° C. will take 4000 × 180 = 720,000 calories; this is true if it remained water, but this amount of heat is by no means enough to convert the water into steam, *i.e.*, to provide the so-called latent heat of evaporation. So that, whilst it might be correct to say that a consumption of 1000 kg. of hot water per hour at 190° C. would take 225 kilowatts, it is very far from the truth to say the same of 1000 kg. of steam.

To convert 1000 kg. of water at 10° C. into steam at 190° C. will take, not 180, but about 635 calories per kg.; in other words, 635,000 calories per hour must be provided; and if 1 calorie in the boiler requires 1·275 watt-hours, the electrical energy will have to be supplied at the rate of 810 kilowatts, or more than three-and-a-half times the figure given.

An electric locomotive taking 810 kilowatts might be relied upon to give 700 to 900 effective horse-power; the electric steam locomotive taking the same electrical power, and evaporating steam at the rate of 1000 kg. per hour, would not give more than 100 to 125 effective horse-power, if so much.

Your obedient servant,

Arnold G. Hansard.

53, Victoria Street, Westminster, S.W.,
March 9, 1904.

Snake Stones.

To the Editors of "Knowledge."

Sirs,—Some time ago I was much interested in a series of articles in the scientific column of a weekly paper on the subject of "Snake Stones." Nothing was said at the time in connection with Brazil, and as I lived in that country for several years it may be interesting to some of your readers to have a word on the subject. "Snake stones" are not stones at all, at any rate not in Brazil, and I should think they would be much the same all over the world. In the articles above referred to there appeared to be great doubt as to what they are. The only ones used in the part of Brazil where I was were made from the horns of young deer, burnt or carbonised in a peculiar manner, which leaves it very suctorial, and which is kept as a close secret by a very few men who make them for sale or barter, and try to make out that they have almost supernatural power to heal snake bites. They are usually sold in pairs, and are not by any means common. In form they are about one inch in length, four-sided, and slightly tapering to one end. When anyone is bitten by a snake, one of these "stones" is placed on the spot and held close, while a band of some sort is tied tightly round the limb a little way back towards the trunk. The "stone" is allowed to remain on the wound until its own weight makes it fall off, when it is presumed all the poison has been extracted. It is then dropped into milk and allowed to soak. It is said that if the person is to get healed the milk will turn to a dark brown colour, the fact being, I suppose, that the blood held by the stone has that effect. As usual with these things, there are many superstitious beliefs in connection with these "stones,"

and the cure is supposed to be miraculous; whereas I suppose that it is really due to the great capillary attractive force they possess, which extracts a certain amount of blood, and with it the poison. After being thoroughly washed out and dried they are ready for another occasion. Yours truly,

James Searle.

[Some experiments recently made in the Government Bacteriological Laboratory of Natal have shown that the mysterious curative properties ascribed to snake stones are quite illusory.—Editor.]

The Ancestry of the Elephants.

Sir,—In the very interesting article on the above subject by Dr. Smith Woodward in the February number, I notice that he calls the fig. No. 6 on p. 13—(Head of *Tetrabelodon angustidens* restored)—a fanciful sketch. As a matter of fact, there has been introduced into it a series of circular wrinkles evidently copied from those on the proboscis of the African elephant figured just above it. But it is clear that, as this proboscis was not pendent, no such wrinkles would appear. Moreover, it would seem more probable that its form would not be circular, but rather shaped to fit the elongated chin.

In that case the mouth would act as a long pair of leathery tweezers, very suitable (with the help of the incurved tusks) for gathering in large mouthfuls of long, quick-growing marsh vegetation. The sharp incisors would enable this to be quickly cut off, and the ponderous animal could without delay move his weight on to firmer ground to masticate the food at leisure.

As the species moved further north to harder ground and tougher vegetation, a more prehensile grip would be useful rather than a speedy way of gathering food together, whereas the incurved tusk and elongated mandible would not only be useless but highly inconvenient. Thus as the proboscis became longer and rounder, the lengthened chin disappeared entirely; and the mammoth with its highly developed molars was able to subsist even on the hard and tough vegetation within the Arctic Circle.

Herbert Drake.

Verwood, Dorset, February 26, 1904.

REVIEW OF BOOKS.

Animal Studies, by David Starr Jordan, Vernon Lyman Kellog, and Harold Heath. (New York and London: Appleton and Co., 1903.) This admirable little treatise is one of the "Twentieth Century Text Books," and bears a very close resemblance to the volume on "Animal Life"—also of this series by the same authors—reviewed in the columns of "Knowledge" in 1901. It differs indeed, mainly, in the addition of several chapters on Classification; and on the economic value and past history of animals. As an elementary text book of Zoology it must take high rank among works of its kind, and will doubtless find a ready sale in this country. Here and there, however, great opportunities have been missed, and more or less serious mistakes are made. Thus, in the chapter on the Classification of Birds, the auks and puffins are placed with the grebes and divers, the authors having been apparently led astray, like the older systematists, by the curious structural resemblance which these birds present in common. As a matter of fact, however, the resemblance to the grebes and divers which the auks, puffins, and guillemots present are entirely adaptive. Their nearest relatives are, without question, the plovers and gulls. So, too, with the gulls and terns, these have nothing whatever to do with the petrels and albatrosses with which they are associated in this book. The resemblances which they severally present are again adaptive. It is equally misleading to place the owls with the accipiters. Turning to the mammals, we may remark that, as with the birds, the classification adopted is antiquated. Nevertheless, in spite of the defects to which we have drawn attention, the work is one which we can heartily commend.

Pictures of Bird Life, by R. B. Lodge (Bousfield), illustrated; 27s. 6d. net.—Mr. R. B. Lodge has produced a most delightful book. The illustrations, which are very numerous, are all reproduced from his own photographs of birds and their nests taken from life. We see many such photographs nowadays, but none better than those reproduced in this book. There are eight full-paged plates reproduced by the three-colour process from photographs coloured by hand. We must confess that we would sooner have had these photographs without the colouring, which, in most cases, is not altogether true to Nature. The letterpress is interesting, and often very informing. Mr. Lodge has made the most of his opportunities, and tells us how and where he obtained his photographs. He has photographed birds in the Dutch marshes, Spanish marismas, and Danish marshes and forests, and in many places in England besides. He gives many valuable hints to those who would take up bird-photography, and describes several ingenious devices and tricks which he has himself used with success. The most notable of these is his automatic electric photo-trap, whereby he traps the bird's portrait by hiding the camera and inducing the bird by bait or otherwise to touch a piece of silk, and thus set an electric battery at work to release the shutter of the camera. Many of Mr. Lodge's observations on the habits of the birds which he has watched so long and so closely while trying to secure their portraits are most valuable. He may not have discovered much that was unknown, but his remarks are the result of direct and careful observation, and this can never be without great value. There are several repetitions in the book which might have been avoided by more careful editing. The sentence, "The Hooded Crow I do not remember seeing so far south" (Enfield) (p. 124), might be put in a less ambiguous form. The bird is, of course, to be seen commonly further south than London. Mr. Lodge will find that the vibratory noise made by woodpeckers is heard not only in the spring (p. 138). But these are only small points, and are only mentioned in view of a possible second edition of this excellent book.

BOOK NOTICES.

The Grant and Validity of British Patents for Inventions, by James Roberts, M.A., LL.B. (John Murray, one vol.; price 25s.). This work has been written for and from the point of view of the inventor. It is intended to enable him to confine his claims to what can be supported and to avoid errors in his specification. The first part consists of the principles and rules affecting the grant and validity of British patents, and the practice respecting the amendment of specifications both before the Comptroller-General and the Law Officers of the Crown; the second part of abstracts of cases, illustrating the application of these principles; and the third part, the statutes and rules. The scope and tenour of the book are such as to make it useful to practising lawyers as well as to inventors.

Mathematical Crystallography, by Harold Hilton, M.A. (Oxford: The Clarendon Press). Mr. Hilton's expressed purpose is to collect in this volume those results of the mathematical theory of crystallography which are not provided in the modern text books on that subject in the English language. He includes a valuable summary of the geometrical theory of crystal structure which the labour of Bravais Jordan, Schneke, Fedorow, Schoenflies, and Barlow have now completed. It is a student's book; an advanced, but an extremely valuable one.

Zoology, Descriptive and Practical. (Two Vols. D. C. Heath; price 4s. 6d. and 2s.)—The general plan of the volumes is to introduce each of the larger groups of animals by a careful study of a typical representative.

BOOKS RECEIVED.

The Naturalist's Directory (L. Upcott Gill):—Introduction to the Study of Physical Chemistry, by Sir William Ramsay—a wholly admirable allocution to students. (Longmans, Green.)

Martin's Up-to-Date Tables of Weights and Measures. (T. Fisher Unwin.)

Modern Navigation, by W. Hall, R.N. (Organised Science Series.) University Tutorial Press.

Second Stage Botany, by J. M. Lowson. (Organised Science Series. University Tutorial Press.

Entropy, by James Swinburne. (Constable.)

The Model Engineer Series. X-rays, Simple Experiments in Electricity, The Locomotive, Acetylene Gas. (Percival Marshall.)

A School Geometry. Parts I.-IV., by H. S. Hall; IV. and V., F. H. Stevens. (Macmillan.)

We have received from Messrs. Nalder Bros., of Westminster, their catalogue of **Electrical Testing and Scientific Instruments.** The catalogue is, in itself, an extremely interesting summary of the investigations now being carried on in various departments of research, and special attention may be directed to the photometric apparatus.

The following books are in preparation at the Clarendon Press:

Suess' "Das Antlitz der Erde," authorised English translation, by Dr. Hertha Sollas, edited by Professor W. J. Sollas, with preface by Professor Suess for the English translation. Royal 8vo.

"Index Kewensis Plantarum Phanerogamarum." Supplementum secundum. 4to.

Goebel's "Organography of Plants," authorised English translation, by I. Bayley Balfour, M.A., F.R.S. Vol. II. Royal 8vo.

Mr. Henry Frowde will also publish shortly:

"A History of the Daubeny Laboratory," by R. T. Günther.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Royal Microscopical Society.

February 17. Dr. Henry Woodward, Vice-President, in the chair. An old microscope by Bate was exhibited, probably made early in the last century. Mr. Stringer contributed a paper on an attachment for reading the lines in a direct-vision spectroscope, and Mr. E. M. Nelson a paper on the vertical illuminator. The author said that, after lying in abeyance for 25 years, the vertical illuminator had lately come into notice for the examination of opaque objects, and especially for the microscopical examination of metals. He criticised the four forms of this apparatus at present sold, namely, those known as the Tolles, Beck, Powell, and Reichert forms, and said that a vertical illuminator must not be an oblique illuminator, but must be capable of illuminating the full aperture of the objective with a parallel beam of light. It must not impair the use of the objective for ordinary work, and must, therefore, not be a permanent attachment. The reflector must be placed near the back lens, and there must be some method for regulating the illumination. Mr. Nelson found that the Powell form, which, like Beck's, consists of a nosepiece containing a reflector, more nearly conformed to these conditions, but the reflector should be made much larger and the hole in the side of the nosepiece should be as large as the Society's gauge. To obtain the best advantage with vertical illumination oil-immersion objectives should be used. The distance from the source of light to the mirror and thence to the objective should be equal to the distance from the eyepiece to the objective. At the hole at the side of the nosepiece there should be a carrier for diaphragms of various sizes in preference to a wheel of diaphragms or an iris. There should also be a strip of metal with a slit in it which could be drawn across the hole in the nosepiece, and the direction of the slit should be in a line with the edge of the flame of the microscope lamp. Another paper by Mr. Nelson, "On the Influence of the Antipoint on the Microscopic Image Shown Graphically" was also read. The author referred to a paper in the *Journal* for 1903 on "A Micrometric Correction for Minute Objects," wherein he stated by way of illustration that, if one of the minute spinous hairs on a blowfly's tongue was examined on a bright ground and on a dark ground, a considerable difference in the sizes of the two images was discernible, and that the difference was caused by anti-points. A table was also given showing the amount to be added to the micrometric measurement of the image seen on the bright ground to bring it up to its true value. Mr. Gordon, who had originated the theory of the anti-point, had made accurate drawings of the two images of the hair, and the ratio of the breadths of the hair in the drawings was as 45 to 65. Applying the corrections given in the table to the measurement of the apparent size of the hair on a bright ground, the actual size works out to 12 per cent. more. A difference in the apparent size of objects when viewed on a bright or dark ground was recognised many years ago, but never explained, but Mr. Gordon's admirable anti-point theorem has unlocked the riddle. Mr. Keith Lucas followed with a paper "On a Microscope with Geometric Slides," the principle enunciated being applied by the author of the paper to the fine and coarse adjustments and to the sub-stage of a microscope, which was illustrated by lantern slides.

The Quekett Microscopical Club.

The annual general meeting was held on February 19 at 20, Hanover Square, the President, George Massee, Esq., F.G.S., in the chair. After the usual business had been transacted, a ballot was taken resulting in the election of Dr. Edmund J. Spitta, F.R.A.S., as President for the ensuing year. Mr. Frank P. Smith was elected Editor in succession to Mr. D. J. Scourfield, and Mr. Arthur Earland, Secretary. Dr. G. C. Karop, who has held the secretaryship for over twenty years, goes into well-earned retirement, carrying with him the gratitude and esteem of all the members. The other officers were re-elected.

The President delivered his annual address, dealing with the commoner fungoid diseases of garden trees and plants. These may be divided into two groups, according to whether the mycelium of the fungus is situated in the woody tissues of the plant ("perennial mycelium"), or whether only the season's growth, the leaves and fruit are affected. The first division, of which the well-known "peach-curl" is an instance, is by far the more serious of the two, it being practically impossible to cure a plant which has become badly infected. In the second division, the plant becomes automatically purified, for a time, on the removal of the infected leaves, &c., either artificially or in the course of nature, and if suitable measures are taken to prevent the germination of the spores in the following season, the plant may be wholly cured. Fire is the best destructive agent; the infected leaves should be burned. Spraying is ineffectual, for the mischief is under the surface, and spraying tends to spread the disease to fresh hosts by washing the spores off the infected plants.

The chief causes of fungoid disease in cultivated plants are overcrowding and the use of chemical manures, which kill the nitrifying bacteria of the soil and stimulate the plant to an excessive and weakly growth.

After the usual votes of thanks, Dr. Spitta was installed in the Presidential Chair, and in returning thanks for his election, referred to the analogy between the fungoid diseases of plants and the zymotic diseases affecting man, especially typhoid and diphtheria.

It is an open secret among microscopists that the Quekett Club's position at 20, Hanover Square has lately been somewhat precarious, owing to the general rise in rents and the keen demand for accommodation in the building of the Royal Medical and Chirurgical Society. I am therefore glad to be able to say definitely that the Committee has succeeded in obtaining an extension of their tenancy in their old quarters, with retention of all their present accommodation, though at a considerable increase of rent, which will, I trust, be justified by a corresponding increase of membership. To the amateur microscopist, especially the Londoner, the Quekett Club, with its very low subscription of 10s. per annum, without entrance fee, offers many advantages. The announcement was made at the annual meeting that a new catalogue of the Club's fine library of about 1300 volumes was in course of publication, and this should still further increase the popularity of the Club. Applications for membership and inquiries relating to the Club should be addressed to the Hon. Secretary, Mr. A. Earland, 31, Denmark Street, Watford, Herts.

The Journal of Applied Microscopy.

I am informed by Messrs. A. E. Staley and Co. that the American Journal of Applied Microscopy will be discontinued after the appearance of the November and December numbers of last year. This is a matter for sincere regret, as the journal, though distinctly technical, was a really valuable one, and it is unfortunate that it should not have met with sufficient support to justify its continuation. We are none too well supplied with microscopical literature, and it is strange that endeavours to provide for our deficiencies in this respect do not meet with more support. I fear that in the case of the journal referred to, the unfortunate and recurring arrears of publication, due, I believe, to the regrettable illness of the Editor, was responsible for the loss of its little support. Those of our readers who may wish to complete their sets may be glad to know that Messrs. Staley have a large number of back numbers in stock, and will be pleased to send them to any subscribers for the sum of 2d. each.

New Pond Life Tanks.

Messrs. Flatters and Garnett, of Deansgate, Manchester, have sent me for inspection a new tank for the study of pond life. It is made of one solid piece of glass, and is not unlike an ordinary large goblet with flattened sides and square corners, standing on the usual round stem and foot. The sides are polished on the outside to prevent the usual distortion due to the unevenness of glass, and the depth from front to back is such that an ordinary pocket lens can be conveniently used. The size of the tank sent to me was 2[illegible] inches high, 2 inches wide, and [illegible] inch deep, and it was very steady. Leakage was of course impossible, the tank was easy to clean, and the price very moderate—namely, 3s. 6d. I understand these tanks are made [illegible] inch high, 1[illegible] inch wide, and [illegible] inch deep at about half the price of the stand mentioned above, and also in a larger and more elaborate form, lined with opal glass and mahogany frame at the ends and bottom.

Preserving Orthoptera.

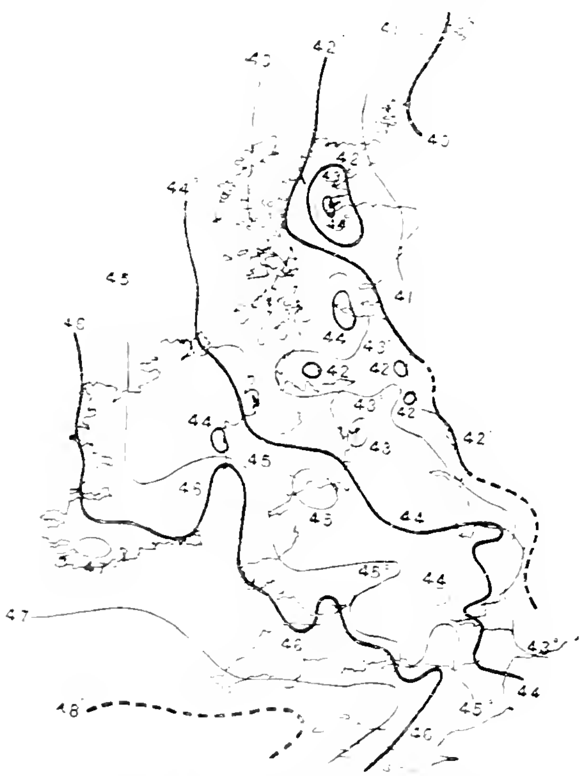
Mr. J. W. Williams, M.R.C.S., F.L.S., writes to me, in connection with the note last month on preserving orthoptera, that he has found dipping the specimens into a weak solution of albo-carbon in benzole is a better preservative against mould than the carbolic acid plan therein suggested, and a better curative also for mouldy specimens. Mr. Williams says he has tried this plan consistently with satisfactory results.

Chess Column.

WITH reference to our note last month requesting opinions on this subject, we have to state that, having only received nine replies, of which seven were in favour of the retention of the Chess Column, we feel that the subject is not one of sufficiently widespread interest to warrant our devoting the space to it, and, therefore, we must, for the present at all events, discontinue the Notes and Problems.

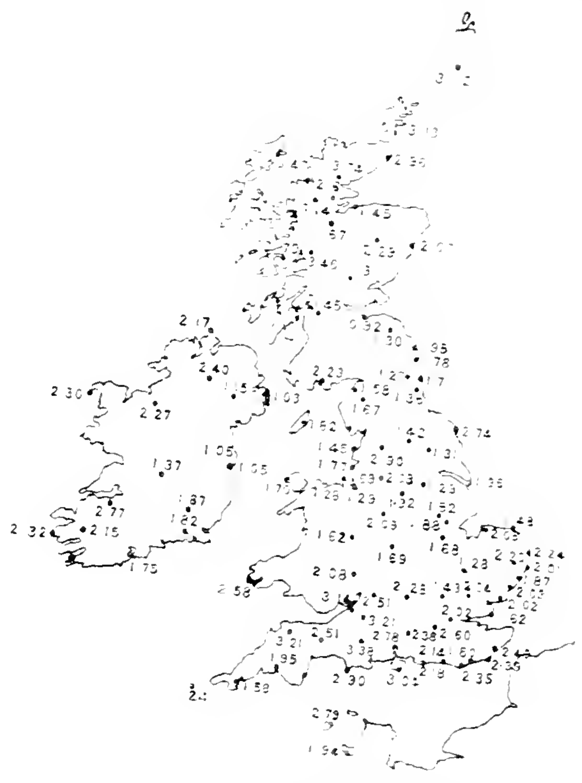
LAST YEAR'S WEATHER—APRIL, 1903.

DISTRIBUTION OF MEAN TEMPERATURE.



The general distribution over Scotland differed from the normal, the isotherms having a north and south direction instead of west and east. Elsewhere the differences were less marked. The actual values were, without exception, below the average the deficiency as a rule being from 2° to 3½°.

RAINFALL.



Rainfall was very irregular both as regards the quantity and the frequency, there being localities of excess and of defect in each district, some stations having twice as many days with rain as others in the same neighbourhood.

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

VOL. I. No. 4. [NEW SERIES.] MAY, 1904. [Entered at Stationers' Hall] SIXPENCE.

Contents and Notices.—See Page VII.

Radio-Activity and Radium.

By W. A. SHENSTONE, F.R.S.

I.

WE owe the discovery of radio-activity, and therefore that of radium, to an accident, though the phenomenon itself might almost be said to be a common one. Radio-activity was first noticed by M. H. Becquerel, who, stimulated, perhaps, by Röntgen's brilliant discovery of the X rays, was looking, in 1896, for yet other new radiations.

The accident was as follows: There is a salt known as potassium and uranium sulphate which, when it is exposed to sunlight, becomes for a moment self-luminous, and Becquerel was studying this phenomenon photographically.

His experiment consisted in placing crystals of the salt above photographic plates well protected from light by means of black paper, and then exposing the salt, which was outside the black paper, to the direct light of the sun. When he did this it became evident that some radiation or some emanation was produced which could penetrate the paper, for the photographic film immediately below the salt was so acted upon that when the plate was developed he obtained a silhouette of the crystals more or less like that shown in fig. 1, though this particular silhouette was given by a little radium bromide, and not by the uranium salt studied by Becquerel.

FIG. 1.—*Silhouette [illegible] Radium.*

One day, just as everything was ready for an experiment, clouds covered the sun, and Becquerel put away his plates with the crystals upon them, thinking them spoilt. Several days afterwards he developed the plates and found to his surprise that the silhouettes were particularly strong ones. He found, in short, that the sun was not needed to stimulate the salt: that this latter, without any such stimulant, radiated or emitted something which was able to penetrate black paper and act like light on a sensitive photographic plate. He found as the result of further experiments that this was no temporary quality of the salt. It persisted for days and months, and, as he discovered subsequently, even for years. Further, the same power was possessed by other uranium salts and by the metal uranium. Anyone who can take photographs can verify all this for himself quite easily.

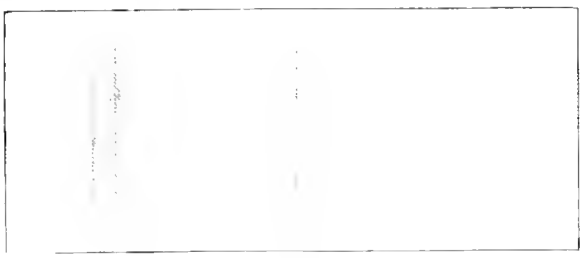
The radiations thus discovered by Becquerel are called "Becquerel Rays." They resemble the Röntgen rays in many respects, and at one time were regarded as due to Röntgen rays. Thus, they cause damp dust free air to deposit fog, make air conduct electricity, will pass through such substances as paper, glass, paraffin, quartz, sulphur, Iceland spar, and thin layers of metal even more freely than Röntgen rays, and they cannot be reflected, refracted, nor polarized like the waves of which ordinary light is composed. It was found, further, that they are not homogeneous, but consist of several different radiations which can be filtered off from each other as it were, and can then be distinguished by their separate characteristics.

Bodies which emit these remarkable radiations are said to be "radio-active." As we shall see presently, other metals besides uranium are radio-active, and also the waters of some springs, as, for example, the waters at Bath, and even solid earth.

Becquerel's great discovery soon proved prolific. It suggested to Madame Sklodowska-Curie the idea that the great radio-activity of specimens of pitchblende, which exceeded that of the uranium present in them, must be due to special constituents, and so in her hands and those of others led to the discovery of polonium, radium, and actinium. And the remarkable properties of these new substances in their turn have started new ideas or revived old ones in several departments of science.

Madame and Monsieur Curie and their colleague, M. Bémont, discovered polonium and radium, and M. Debierne was the discoverer of a third substance of the same class, actinium. The method of working was to separate the components of the pitchblende, which is a very complex mineral, and to study the radio-active power of each constituent. The results obtained with the bismuth and barium from this mineral arrested attention, and presently it was found that the former was associated with the sub-

stance now called polonium, and the latter with the radium which plays such an important part in modern science. Neither polonium nor actinium have as yet been isolated in the form of a salt. The former in many ways resembles bismuth, and its nature still remains doubtful. Radium, on the other hand, yields salts—*e.g.*, a bromide, a chloride, and a nitrate. Its combining weight has been fixed by Madame Curie at 112·5, and 225 is suggested for its atomic weight. It exhibits a definite flame spectrum, which has been recorded by Messrs. Runge and Precht, and which is given in fig. 2, whilst its spectrum in the ultra violet has been studied by Sir William Crookes and others, and affords a means of identifying it.



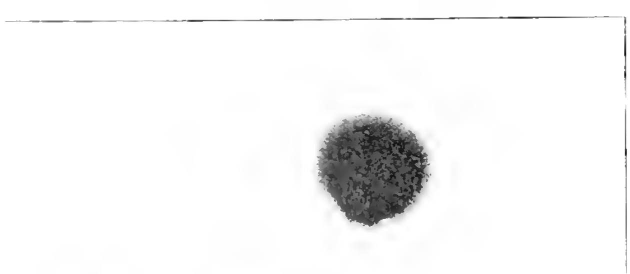
d cb *a*

FIG. 2.—The Flame Spectrum of Radium.
The line *a* has the wave length 4826, *b* 6329, *c* 6349, *d* 6653. There are bands about *b c* and *d* as shown above.

Radium is generally regarded as an element, but as the total quantity of the pure radium salts yet made would be insufficient to fill a small egg cup, this statement must still be taken with some reserve. The so-called pure salts of radium possibly may be mixtures, but, for the present, in the absence of any evidence to the contrary, we may assume them to be salts of a new and peculiar elementary substance radium.

Radium the element has not been isolated. Its salts are so valuable, and the process of separating it probably would be so wasteful, that it seems unlikely anyone will attempt to prepare elementary radium at present.

The process of purifying a radium salt has not been very frequently described, but it is simple enough in principle. The raw material is the residue left after the uranium has been extracted from pitchblende. A ton of this material suitably treated may yield 10 or more kilograms of a mixture consisting chiefly of the sulphates of barium, lead, iron, and calcium, with a trace of radium. This is converted into carbonates by heating it with a solution of carbonate of soda, and the carbonates are dissolved in hydrochloric acid, which converts them into chlorides. The lead and iron in the mixture of chlorides thus produced are got rid of by means of sulphuretted hydrogen and ammonium sulphide, and the remaining barium, calcium, and radium are reprecipitated as carbonates, again converted into chlorides, and then washed with strong hydrochloric acid to remove the calcium chloride. The residue consists of barium chloride containing a trace of radium chloride. This is dissolved in hot water and allowed to crystallize partially. The crystals, which contain most radium, are separated from the liquid portion, and the latter is then evaporated to recover the remaining salt, and each of the two portions thus produced is similarly fractionated. By systematic work of this kind products were obtained first nine hundred times as radio-active as uranium, then five thousand times as active, then fifty thousand times, and at last, it is said, a million times as active as the standard substance, the removal of the barium salt at the later stages being facilitated by using solutions of hydrochloric acid in place of water for dissolving the mixture of barium and radium chloride.



B A

FIG. 3.—Radiographs of radium salt and uranium taken simultaneously.

Some idea of the difference between the activity of uranium salts and of radium may be got from fig. 3. On the reader's right is the silhouette A, given by one-sixth of a grain of radium in fifteen minutes. The area about the faint dark mark above B a little to the left of this shows the effect of a much larger quantity of a uranium salt, the two being exposed side by side over the same plate. The uranium salt, as will be seen, gave no sensible result at all. The small dark mark above B was added to indicate the centre of the area exposed to the uranium.

The salts of radium, in their ordinary reactions, resemble those of barium rather closely, but in other respects they are remarkably different. Thus, they are visible in the dark, and continuously evolve heat; so that a heap of a radium salt is always hotter than the air around it. So great is the amount of heat evolved that a gram-atom of radium gives out in a year as much heat as a gram-atom of hydrogen when it is burnt in the oxyhydrogen flame, and, moreover, as far as we know, the radium would go on giving out heat at this rate for many centuries. Its powers are destroyed to a great extent if it is strongly heated (see emanation), but are recovered spontaneously after a few weeks on cooling.

Radium, or rather its radiations, are very destructive. A piece of cambric placed above a box containing a little radium salt was found by Lord Blythswood to be pierced with holes after two or three days. A photographic film exposed to one-sixth of a grain of radium bromide in the author's laboratory for four hours by Mr. W. D. Rogers (who has kindly prepared many of the figures given in this article) yielded no silhouette because the film was completely disintegrated and its remains washed away during the developing process; and the caustic powers of radium salts, as is well known, are thought likely to prove useful in surgery, and have sometimes produced very unpleasant effects when specimens of the salts have been kept too long near the human body. Its power of making air conduct electricity is shown by the way in which a tassel of silk electrified by rubbing with india-rubber collapses when radium is brought near it, and by the rapid collapse of the leaves of a charged gold leaf electroscope under similar circumstances. But the prettiest way of observing this property of radium is as follows:—

Connect a spark gap at B, fig. 4, with an induction coil and with a vacuum tube A—a large vacuum tube gives the best result—as in the following figure. Arrange matters so that the coil gives a very steady discharge at the spark gap, and then draw back the point and plate till the discharge just passes through the vacuum tube, only an occasional spark crossing at B. Then bring the radium close to the spark gap. When

you do this the vacuum tube will go out and the discharge will not be re-established at the spark gap till you remove the radium salt.

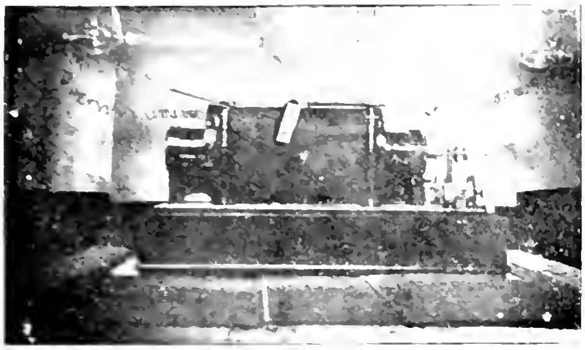


Fig. 4.

The coil must not give too strong a discharge, and the discharge must be very steady. If this is secured, the experiment can be brought off with great certainty every time.

(To be continued.)

Modern Views of Chemistry.

By H. J. H. Fenton, F.R.S.

A few further illustrations may be given of the simple explanations which the ionic-dissociation hypothesis affords of the properties and reactions of salts in solution. Since salts are highly ionised when dissolved in even a moderate quantity of water, the properties of the solution represent the joint or added properties of the ions into which the salt has split up. The colour of the solution, for example, is that of its ions: solutions of most common cupric salts are blue and nickel salts green. This is because the acid-radicles (sulphate, nitrate, &c.) happen to give colourless ions and the colours observed are therefore due to the metallic ions. Most permanganates are pink and manganates green in solution, because the metallic ions (potassium, sodium, &c.) happen to be colourless and the colours here are due to the acidic ions. It is interesting to observe in this connection that some ions may be correctly represented by the same chemical symbol and yet show different colours and other properties in solution. Both the manganate ion and the permanganate ion are represented by the symbol MnO_4, yet one is green and the other pink. The copper ion again is blue when in the cupric state, but colourless in the cuprous state. This is explained by saying that the electric charge associated with the ion is different in the different states. A well known and simple experiment in illustration of the above views may be made as follows: Dissolve some dry cupric chloride, which is brownish yellow, in a very little water; the solution appears green. Dilute it, and it becomes blue: add a strong solution of hydrochloric acid or sodium chloride and it turns green again. Repeat the latter part of the experiment, using mercuric chloride instead of sodium chloride, and the solution remains blue. The "ionic" explanation is that the very strong solution first made contains some molecules of cupric chloride (impure yellow) mixed with copper ions (blue) and this mixture gives to the eye the appearance of green. On diluting, the cupric chloride molecules are further ionised, giving therefore less yellow and more blue. If, however, a strong solution of a metallic chloride is added, its chlorine ions, being in great concentration, prevent the further ionisation of the cupric chloride, according to well known principles which will be discussed later. It happens, however, that mercuric chloride is an exceptional salt in that it is only very slightly ionised when it is dissolved in water; there are scarcely any free chlorine ions in its solution therefore, and it can have little influence in checking or reversing the ionisation of the cupric chloride.

The colour-changes of the indicators which are used in analysis, such as litmus, may be explained in a similar way. We may regard these indicators as behaving like very weak acids and the colours they show in acid solutions, where they are very little, if at all, ionised, is the colour of the compound or molecule (red in the case of litmus). But now on adding an alkali a salt is formed, and this, like nearly all salts, is highly ionised in solution, so that we now see the colour of the acidic ion (blue in the case of litmus). The colour changes of other well-known indicators can be similarly explained; in phenol phthalein the molecule is colourless, the acidic ion pink, whereas in the case of methyl-orange the molecule is pink and the acidic ion yellow.

This very simple and attractive explanation of the colour-changes in indicators has, it must be confessed, received rather a severe "shaking" owing to certain recent observations, and it is probable that the effects depend rather upon changes of constitution in the indicator.

Not only the colour but the reactions of a solution of a salt are considered to be due to its ions; a solution of ferrous, or ferric chloride, for example, gives a precipitate with alkalis due to the iron ion and a precipitate with silver nitrate due to the chlorine ion. Potassium ferrocyanide, however, gives no precipitate with alkalis, although it contains iron, and chloral gives no precipitate with silver nitrate although it contains chlorine. The potassium ferrocyanide contains its iron associated with cyanogen as a complex group, and when dissolved gives potassium ions and ferrocyanide (FeC_6N_6) ions; none of the iron, as such, being present in the ionic state. Chloral again gives a solution which contains no chlorine ions: the chlorine is combined with the other elements as an undissociated molecule.

Mercuric cyanide has long been known as abnormal in its behaviour, since it answers scarcely any of the usual tests either for mercury or for a cyanide. It can be shown in various ways, however, that the salt is practically dissolved unchanged: its solution contains neither mercury ions nor cyanide ions. The poisonous character both of mercury salts and of cyanides is assumed to be due to their ions; therefore we should expect mercuric cyanide to be non-poisonous. This is stated to be the case, although it does not appear that any ardent supporter of the "ionic" theory has had the strength of mind to try its effects upon himself.

The most "chemically active" substances then in solution are those which are most ionised. It does not follow, however, that all chemical changes which may take place in solution are necessarily ionic changes. It has been shown, for example, that certain salts and acids undergo immediate double decomposition when dissolved in solvents in which no ionisation occurs.

The action of a strong acid upon the salt of a weak acid was formerly looked upon, as indicated above, as

due to the strong acid appropriating the base and turning the weaker acid out. For example—

Sodium acetate + hydrochloric acid = sodium chloride + acetic acid.

But the ionic view is quite different. Here we assume that sodium ions + hydrogen ions + chlorine ions + acetic ions give sodium ions + chlorine ions + slightly ionised acetic acid, the change consisting in the union of hydrogen ions with acetic ions, the others remaining unchanged.

It is well known that many salts which are "normal" in the chemical sense yet give an acid or an alkaline reaction when dissolved in water. Thus sodium borate or sulphite shows an alkaline reaction, whereas aluminium sulphate or ferric chloride react acid. This may be explained by assuming that the salt is partly hydrolysed by water in the first instance, giving acid and base in equivalent quantities. But if the base is strong and the acid is weak the former will be largely, and the latter slightly, ionised; so that the solution will contain an excess of hydroxyl over hydrogen ions, and will therefore react alkaline. If the base is weak and the acid strong, there will, for similar reasons, be an excess of hydrogen over hydroxyl ions, and the solution will be "acid."

Many of the ordinary chemical changes may be represented as consisting in an exchange of electric charges between the ions, or in the assumption of charges by neutral substances whereby they become ionic, and a corresponding loss of charges by the ions whereby they become "ordinary" or neutral substances. When dilute hydrochloric acid acts on zinc, for example, the metal passes into the ionic state, assuming positive charges; whilst the ionic hydrogen gives up its positive charges, becoming ordinary hydrogen gas, the chlorine remaining in the ionic state throughout. When stannous chloride is converted in stannic chloride, in solution, by chlorine, the change may be regarded as consisting in the assumption of two additional positive charges by the tin ion and the assumption of two equal and opposite negative charges by two atoms of neutral chlorine, which thereby becomes ionic. In this action the tin is said to change its valency from two to four (*i.e.*, from the stannous to stannic form), the valency, in fact, being in this sense measured by the number of unit charges with which the atom is associated when in the ionic condition.

The late Mr. H. C. FYFE.

It is with the deepest regret that we have to record the death of one of our contributors, Mr. Herbert Fyfe. Mr. Fyfe was only thirty years of age, and his death, though not entirely unexpected, was none the less sudden. He leaves a gap in scientific journalism that none can fill as well as he. Possessed of extraordinary industry and energy, and gifted with a quite unusual capacity for assimilating the main details of the matter in hand, he wrote articles on many subjects besides the one which was his chief interest—"Submarine Warfare"—and his work never missed its mark. The loss to scientific journalism is great; but the loss to his wide circle of friends is irreparable. One of the kindest and most generous of men, one of the most helpful of colleagues, he leaves behind him a memory not alone of goodness of heart or soundness of mental fibre, but of a moral nature that was a great example of courage and sweetness.

Modern Cosmogonies.

VIII.—Protyle: What is it?

By Miss Agnes Clerke (*Hon. Mem.*), F.R.A.S.

The notion of a primordial form of matter meets us at every stage of cosmogonical speculation. It is the outcome of an instinctive persuasion that, if we could only "lift the painted veil" of phenomena, the real business of the universe would be found to be proceeding in the background, on a settled plan, "without haste or rest;" that uniformity is fundamental, diversity only incidental; and that the transformations of the one simplified substance might be represented by a single formula, the discovery of which would place in our hands the master-key to the locked secrets of the universe. Among untutored thinkers, some familiar kind of matter, idealised and generalised, commonly stood for the typical world-stuff. Water was the first favourite. Thales, the "wise man" of Miletus, procured his Cosmos by precipitation from an aqueous solution, and many savage tribes have devised analogous expedients. Anaximenes preferred air for the universal solvent; Heracleitus substituted fire, and set on foot a scheme of what is now often designated "elemental evolution." From the perpetual "flux of things," he conceived that the four substances selected by Empedocles as the bases of Nature were not exempt; and a fragment of his scheme survived in Francis Bacon's admission of the mutual convertibility of air and water. In the main, however, the author of the "Novum Organum" adhered to the Paracelsian doctrine of an elemental triad,* while rejecting the saline principle, and retaining, as the material substratum, sulphur and mercury.†

These twilight fancies faded in the growing light of chemical science; yet the mental need that they had temporarily appeased survived, and had somehow to be satisfied. An "Ur-Stoff" was still in demand; but the nineteenth century characteristically attempted to supply it by weight and measure. Dalton's combining equivalents afforded the warrant for Prout's hydrogen hypothesis. The problem to be faced was to find a unit-atom by the varied combinations of which all the rest of the chemical atoms might be formed. The condition indispensable to be fulfilled was that their weights should be exact multiples of that of the unit, and it came near to fulfilment by the hydrogen-atom or semi-atom. It was, nevertheless, a case in which approximate agreement was of no avail; the adverse decision of the balance finally became unmistakable; and Prout discreetly fell back, in 1831,‡ upon the resource of deriving hydrogen itself "from some body lower in the scale." His hypothesis, in short, dissolved into a conjecture. It had only emphasised the stipulation that the "Protyle" of the ancients must be such as would likewise serve for the unification of all the chemical species.

Meanwhile, the theoretical search for it had been carried on in widely different fields of inquiry. Laplace's speculations, Herschel's observations, had led to the conception of some kind of "fire-mist" as the genuine star-plasm. But its nature and properties remained indefinite, or were assigned at the arbitrary choice of adventurous

* First introduced by Basilius Valentinus. See Fowler's *Novum Organum*, p. 576, note.

† Thus recurring, as Mr. Fowler remarks (loc. cit.), to Geber's earlier view.

‡ *Dict. of National Biography*, Vol. XLVI., p. 425.

cosmogonists. So the "shining fluid" of space was "everything by turns and nothing long," until Sir William Huggins, in 1864, gave it spectroscopic individuality. The "recognition-mark" of nebulium is a vivid green ray, by the emission of which it is known to have a concrete existence. Yet the little that has besides been learned about it discountenances its identification with the *materia informis* of antique philosophy. This we should expect to be the subtlest of all substances. Professor Campbell, however, has gathered indications that nebulium is denser than hydrogen. Its luminosity, at least, which is invariably associated with that of hydrogen, extends further in the same formations; it seeks a lower level. The nebulium atom is not, then, the chemical or the cosmical unit.

This evasive entity, or something that curiously simulates it, has proved to be of less recondite origin. Sir William Crookes is amply justified in claiming the venerable designation of Protyle for the "radiant matter" first produced in his vacuum-tubes nearly thirty years ago. The discovery was astonishing and unsought; and its significance has not yet been measured. Matter assumes the "fourth state," in which it is neither solid, liquid, nor gaseous, under the compulsion of an electric discharge in high vacua. At an exhaustion of about one-millionth of an atmosphere, the manner of its transit abruptly alters. Conduction gives way to convection. Luminous effects are abolished. The tubes cease to glow with brilliant, parti-coloured striæ; the poles are no longer marked by shimmering halos or brushes; only a green phosphorescence is seen where the glass walls of the receptacle are struck by the stream of projected particles. They come, with half the velocity of light, exclusively from the negative pole, the positive pole remaining inert. Hence the name "cathode-rays," bestowed by Goldstein on the carriers of electricity in highly-exhausted bulbs.

These mysterious, sub-sensible agents possess certain very definite properties. Their paths are deflected in a magnetic field; they can traverse metallic films; and their investigation in the open, thereby rendered feasible, has shown them to possess photographic efficacy, and the faculty of breaking down electrical insulation; moreover, they transport a negative charge of fixed amount, and have a determinate momentum. They are then assuredly no mere pulsations of the ether; unless our senses "both fail and deceive us," their quality is material. Material, yet not quite with the ordinary connotation of the term. The most essential circumstance about the cathode-rays is that they remain unmodified by the chemical diversities of the originating gases.† A hydrogen tube yields identically the same radiant matter as an oxygen or a nitrogen tube. Here then at last we have within our grasp undifferentiated substance—matter not yet specialised, neither molecular nor atomic, matter destitute of affinities, exempt from the laws of combination—matter in its inchoate, and perhaps ultimate, form: in a word, the far-sought Protyle.

Already, in 1879, Sir William Crookes conjectured the infinitesimal missiles propelled from the cathode to be the "foundation-stones of which atoms are composed."* And in 1886 he pronounced them more decisively to be the raw material of atoms, which, to Sir John Herschel's apprehension, bore the unmistakable stamp of a "manufactured article."‡ Nor did his recent commentator refrain from attempting distantly to divine the method of their construction, or from laying his finger on the by-products and residues associated with it,* although he felt compelled to relegate the cosmic factory to the edge of the world, where inconceivable things may happen. All this, indeed, seemed, in the late Victorian era, like mounting the horse of Astolfo for a trip to the moon; and sane common-sense pronounced it fantastic enough to "make Democritus weep and Heraclitus laugh."† But we have since learned from Nature herself some tolerance of audacities.

Step by step, the new order of ideas has irresistibly come to the front. It owed its origin to Sir William Crookes's skill in producing high vacua, and the consequent development in his tubes of radiant effects. Then, in 1879, universal importance was claimed for them, and matter in the "fourth state," by a revival of the dreams of the ancients, expanded into a kind of visionary Protyle. Philipp Lenard made the next advance towards its actualisation by slipping it, in 1894, through an aluminium window, and watching its behaviour towards ordinary matter. Two years later, Röntgen-rays made their entry on the scene; and before the end of 1896, Becquerel, hurrying along the track of novelties, came upon the momentous discovery of radioactivity.

A revision of ideas has ensued. Some time-honoured assumptions have had to be discarded; so-called laws have been found to need qualification; the old system of physics is consequently out of gear, and much time and patient labour must be expended upon the adjustment of the new and improved system destined to replace it. The leading and indisputable fact of the actual situation is that a number of hitherto unsuspected modes of energy have been disclosed as widely operative in Nature. All are of a "radiant" character. They travel in straight lines with enormous speed; they start from a material base, and produce their several effects on reaching a material goal. Now these effects are closely analogous, notwithstanding that the rays themselves are radically dissimilar. Those of the cathodic kind are corpuscular. They consist of streaming particles, each, according to Professor J. J. Thomson, of about one-thousandth the mass of the hydrogen-atom. Others—the noted "alpha rays"—are atomic; they are supposed to aggregate into helium. Finally, the Röntgen variety are ethereal; they are composed of light-vibrations reduced in scale, and augmented correspondingly in frequency. What is most remarkable is that these various forms of activity give rise, by different means, to very much the same results. They are, in fact, distinguishable only by careful observation. They possess in common, though not to the same degree, the faculties of penetrating opaque matter, of impressing sensitive plates, of evoking fluorescence; while under the impact of cathode and Röntgen rays, as well as of ultra-violet light, insulated electric charges leak away and evanesce. There is, however, one clear note of separation between cathodic and X-rays in the sensibility of the former, and the indifference of the latter, to magnetic influence. Thus alone, it would appear, is electrified matter set apart from what we call ether. If flying corpuscles could be obtained in a neutral condition, the distinction would vanish. But this is evidently impracticable. Indeed, advanced physicists abolish the material substratum of the corpuscle, and assign its attributes to the associated atom of electricity. It is, at any

* Crookes, *Phil. Trans.* Vol. CLXX., p. 163.

† J. J. Thomson, *The Discharge of Electricity through Gases*, p. 195; *Phil. Mag.* Vol. XLIV., p. 311.

‡ *Science*, June 26, 1903.

* *Proc. Chem. Society*, March 28, 1888.

† *Times*, March 30, 1888.

rate, undeniable that the electrical relations of matter become more intimate as our analysis of its constitution goes deeper. Ether, electricity, matter, all seem to merge together in the limit; their distinctions ultimately evade definition. So animal and vegetable life appear to coalesce in their incipient stages, and develop their inherent differences with advance towards a higher perfection.

The various branches of inorganic nature, too, possibly spring from a common stock. Our powers of discrimination fail to separate them as we trace them downward; but that may be because of the inadequacy of the guiding principles at our command. A larger synthesis is demanded for the harmonising of multitudinous facts, at present grouped incongruously, or left in baffling isolation, and it is rendered increasingly difficult of attainment by the continual growth of specialisation. Year by year details accumulate, and the strain of keeping them under mental command becomes heavier; yet what *can* be known *must*, in its essentials, be known as a preliminary to extending the reign of recognised law in Nature.

Sooner or later, however, the wealth of novel experience recently acquired will doubtless be turned to the fullest account. Just now, we can grasp only tentatively its far-reaching implications. They have a very important bearing on the hoary problem of the genesis of visible things. The questions of what matter is, and of how it came to be, have been cleared of some of the metaphysical cobwebs involving them *ab antiquo*, and insistently crave definite treatment by exact methods. We should, indeed, vainly aspire to reach—or to comprehend, even if we could reach—an absolute beginning. To quote Clerk Maxwell's words: "Science," he wrote, "is incompetent to reason upon the creation of matter itself out of nothing. We have reached the utmost limit of our thinking faculties when we have admitted that, because matter cannot be eternal and self-existent it must have been created." The discovery that atoms disintegrate into corpuscles does not then bring us any nearer to the heart of the mystery; but it is eminently suggestive as regards secondary processes.

Acquaintance with ultra-atomic matter, begun within the narrow precincts of "Crookes' tubes," has advanced rapidly since "radiology" took its place among the sciences. For, from the time when Becquerel first saw a plate darkened by the photogenic projectiles of uranium, and Madame Curie sifted radium from the refuse of the mines of Joachimsthal, the lines of proof steadily converged towards the conclusion that chemical atoms are not only divisible, but that their decay progresses spontaneously, irresistibly, in fire, air, earth, and water, as part of the regular economy of Nature. To explain further. Radio active bodies are composed—according to Rutherford's plausible hypothesis—of atoms in unstable equilibrium. The gradual changes incidental to their own internal activities suffice to bring about their disruption. And their explosive character is obviously connected with their unwieldy size, since uranium, thorium, and radium, the three substances preeminent for radio-activity, possess the highest atomic weights known to chemistry. The precarious balance, then, of each of these complex, though infinitesimally small, systems is successively overthrown, regardless of external conditions or environment, their constituent parts being hurled abroad with the evolution of an almost incredible amount of energy. Their products include cathode-rays; matter in the "fourth state," matter a thousand times finer than hydrogen, is ejected in torrents from the self-pulverised atoms of radium. Moreover, the issuing rays are equivalent to currents of negative electricity. Each corpuscle bears with it an electron, or is itself an electron; for the choice between the alternatives is open. In either case, we are confronted with matter apparently in its ultimate form; and to that form ordinary, substantial bodies tend to become reduced. Electrons may fairly be called ubiquitous. They occur in flames, near all very hot masses, wherever ultra-violet light impinges on a metallic surface*; they are freely generated by Röntgen and cathode rays; they are the agents of electrical transmission in conductors. Everywhere throughout the universe, then, atoms are in course of degradation into corpuscles. But no information is at hand as to the scene or mode of their reconstitution. The waste and decay are patent; the processes of compensation remain buried in obscurity. Indeed, Sir William Crookes anticipates the complete submergence, at some indefinitely remote epoch, of material substance in Protyle, the "formless mist" of chaos. He assumes an identity between the past state and the future, leaving, however, the present unexplained. The breakup of matter, in fact, does not render its construction the more intelligible. Running-down is an operation of a different order from winding-up. It is an expenditure of a reserve of force. It needs no effort; it accomplishes itself. But to create the reserve for expenditure demands foresight and deliberate exertion; it implies a designed application of power. Now each atom is a store-house of energy representing the force primitively applied to reduce some thousands of free electrons to the bondage of a harmoniously working system. Its disruption is accompanied by the dissipation of the energy previously accumulated in it; and that atomic systems are not calculated for indefinite endurance is one of the most surprising of modern discoveries. The secret of their original construction is, nevertheless, still impenetrable. That they are composed of Protyle—that their clustering members are corpuscles moving under strong mechanical control—is more than probable. And the law of order adumbrated by what are called the "periodic" relations of the chemical elements shows that their concourse was very far from being fortuitous. But beyond this point, there is no holding-ground for definite thought. We are ignorant, too, whether the process of building matter out of Protyle is at present going on, or was completed once for all in the abysmal fore-time, decay being now definitive. Nor is it likely that we shall ever succeed in capturing with recognition a brand-new atom freshly minted for cosmical circulation.

* *Ency. Brit.*, art. *Atom*.

* Fleming, *Proc. Royal Institute*, Vol. XVII., p. 169.

A FREE Public Reference Library, having distinctive characteristics, is in course of formation by the London County Council at the Horniman Museum, Forest Hill. The primary intention is to encourage the study of Geology and the biological sciences (Botany, Zoology, and Anthropology)—especially as represented in the Horniman Museum collections—by providing the best books on these subjects, more particularly the works of admitted authority which, by reason of cost and a relatively small demand, are not ordinarily found in libraries freely accessible to the general public. Although undue importance is not attached to merely descriptive works, a distinctive feature of the library is the prominence given to the special books necessary to a detailed study of any section of the Archæology or the Natural History of the British Islands. Text-books, manuals, and monographs are supplemented by works on the theoretical aspects of every branch of science with which the library is concerned, and books designed to stimulate individual observation and inquiry, including the most recent manuals, British and American, of "nature-study," are liberally provided.

Animated Photographs of Plants.

By Mrs. Dukinfield H. Scott.

The kinematograph has now been in use for many years for successfully reproducing rapid movements of living objects, such as the boat race, an express train in motion, or the Coronation procession. Its use for showing, at an accelerated speed, *slow* movements which cannot be watched by the eye, and which last over a considerable period of time has, no doubt, often been thought of, but has not been put to much practical test. In fact I know that some years ago, two eminent professors of science visited one of the popular places of entertainment to watch a boxing match on the screen, with a view to obtaining hints for the use of the kinematograph for scientific purposes. I did not hear that the experiment went any further.

In the plant world there are many fascinating subjects possible. If photographs of a germinating seed are taken by the kinematograph at regular intervals during many days until the seed has germinated and sent up its seed leaves, the photographs can be thrown on the screen and the spectators can have the pleasure of seeing the earth raised up by the swelling seed, the seed-coat thrown off, the seed leaves emerge, straighten themselves out, and then the first leaves burst forth.

If the plant is a climbing one such as the French Bean, another plate will show the point of the stem swaying round in large circles till it comes into contact with its support, and twines round and round the stick provided for it. Professor Pfeffer, of Leipzig, in 1900, devised a very perfect apparatus of this sort for class demonstration, the photographs being taken by electric light with a film kinematograph. But the expense of this apparatus is too great for the use of amateurs, as, exclusive of the initial expenditure, each new film costs 90 marks = £4 10s. I hope to explain in the following pages the method of working a smaller and less expensive apparatus, which is within the reach of the ordinary amateur photographer.

The first plant selected for experiment was *Sparmannia africana*,* a native of South Africa well known in our greenhouses. A photograph is given of the inflorescence of this plant (fig. 11), which gives some idea of its general appearance. It is a plant which belongs to the same order as the Lime Tree, and has many attractive features;

* Annals of Botany, Vol. XVII., No. LXVIII. Sept., 1903.

Fig. 11.

Sparmannia africana.

Fig. 12.

Fig. 13.

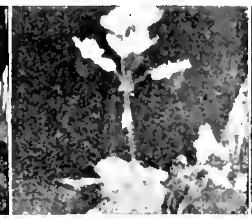


Fig. 14.

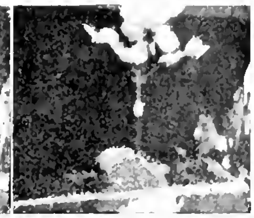


Fig. 15.

Fig. 11 shows the general appearance of the infloresecence, taken at 5 a.m. Flowers just opening from the right position.

Fig. 12.—Photograph 10 shows bud on the left swelling.

Fig. 13.—Photograph 80. The bud is half open, and the bud on the right is in the vertical position, ready for opening.

Fig. 14. Photograph 150. Both flowers open.

Fig. 15.—Photograph 220. Still further open.

Sparmannia africana.

Figs. 1-10. Shows stages selected from the Kammatograph photographs in the opening of a bud.

Fig. 1. Watch the bud.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

the buds, which hang down round the stem, only open in sunlight at a temperature of not less than about 60° F. 26° C., the flowers shut up every night at varying times according to their age, opening again each morning for several days, and each day the flower alters in appearance. This can be seen in the drawing—the buds are hanging round the stem—one flower is just opening; there are two older flowers and several in an upright position which have closed, and are about to form fruits. Then the stamens are sensitive, and when touched move away from the stigma. The way the flowers are arranged on the stem is also interesting: the buds hang down at first, then move upwards during the night, and then bend again into the vertical position before opening as in fig. 1 bud. There is a little joint or pulvinus on each flower stalk where the bend takes place; when the fruit is ripe a layer of cork is formed at this joint and there the fruit is detached. This plant seemed, therefore, a very suitable one for experiment. I aimed at photographing the inflorescence at intervals while young, so as not only to show the opening of the flowers, their closing at night, and the movements of the stamens, but also the development of the inflorescence from bud to fruit. I hoped in this way to show the progress of the plant during several months in a few minutes on the screen.

My first experiments with a film kinematograph, though successful enough to encourage me to proceed, had many defects; the machine was not constructed for this sort of work, and the maker was unable to help in adapting it. The celluloid film would not stand the constant damp of the greenhouse, and this was only one of the many difficulties encountered with this machine. My most successful experiments have been with the Kammatograph, in which the photographs are taken on a glass disc instead of a film. The disc, 12 inches in diameter (half of one is shown in fig. 16) is suspended in a metal ring; it is coated with a sensitive emulsion, just like any ordinary photographic plate, from which it only differs in size. It is capable of taking 350 photographs. When ready for use, the disc is put into the machine, which is light proof, and by means of a handle at the side can be rotated, so that every part of the plate is exposed before the small oblong opening in front of the lens and the photographs appear in a spiral on the disc. In ordinary kinematograph work, the handle is rotated at a uniform speed and a series of snapshots are produced, but for the work now required, it is necessary to take time exposures, as photographs must be taken at all times of the day and in all weathers; a large number of photographs are only wanted when rapid movements, such as that made by the stamens when touched or when a bud is opening, are taking place.

For many parts of the day a photograph taken once every quarter of an hour is sufficient.

The practical difficulties in this kind of photography are rather overwhelming at first, but I have now overcome the principal ones, and think that anyone who cares to try the experiment for himself will find it fairly easy. The expense of each negative plate is 2s. 6d. and the positive is also 2s. 6d., so that the total cost of each completed kinematograph picture is 5s., plus the expense of developing. If this is done professionally, each plate costs 1s. to develop, thus bringing the cost up to 7s. The developing and printing are extremely simple compared with a film negative, as all the 350 photographs are developed and printed at the same time and in the same way as an ordinary plate; this seems to me a great practical advantage.

Two principal points must be considered:—

1.—The apparatus must be quite rigid, as the slightest movement would spoil the whole result. Mr. Kamm has now devised a very satisfactory stand for this purpose.

2.—Each photograph must be exposed uniformly, and, as they have to be taken at all times of day and night, this at first was one of the greatest difficulties. By the use of Wynne's actinometer, this difficulty was completely

Weather Plant (*Abrus precatorius*).

Fig. 22.

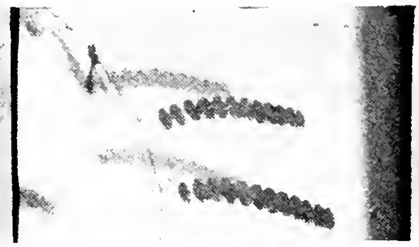


Fig. 23.

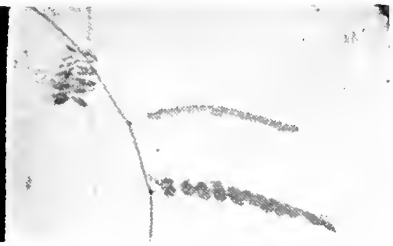


Fig. 24.

Fig. 25.

Fig. 22.—Photograph. Position of leaves at 2.18 p.m., on March 31, 1904.

Fig. 23.—Photograph. Position of leaves at 5.15 a.m., the whole rachis is moving up, though the leaves are not yet open.

Fig. 24.—Photograph. Position of leaves at 10 a.m., April 1, 1904.

Fig. 25.—Shows the night position.

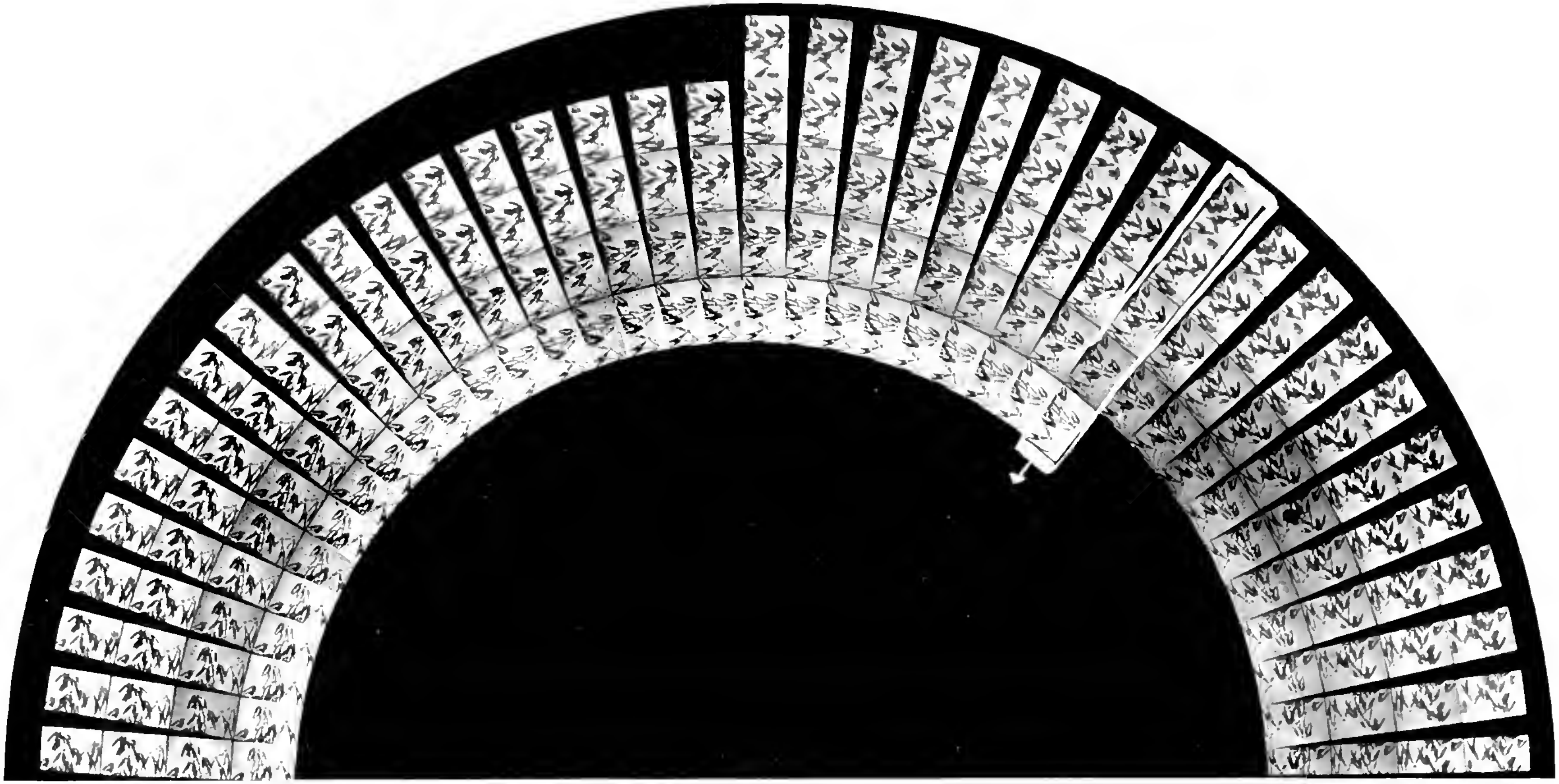


Fig. 16.

SENSITIVE PLANT. *Mimosa sensitiva.*

Fig. 17. Fig. 18. Fig. 19. Fig. 20. Fig. 21.

Fig. 17. Photograph. Shows the leaflets open, just after the match has been applied to the tip of a leaf.
Figs. 18, 19, 20. Photographs. All stages in the closing of the leaflets.
Fig. 21. Photograph. Shows the plant with the leaves almost closed.
In Fig. 16. These photographs are enclosed between white lines.

removed. I at first used magnesium ribbon for the night exposures; but this was very laborious work. I now use an incandescent lamp fed by methylated spirits, but for those who are fortunate enough to have electricity an arc lamp is best of all. When once the right exposure is found all further difficulty in this direction is removed. No doubt the ideal method would be to have a clockwork apparatus for turning the machine which at the same time turned on the light and exposed the plate, as Professor Pfeffer has.

The Sensitive Plant. *Mimosa sensitiva.*

This plant closes its leaves when touched, and also naturally shuts them up at night. The leaf is divided into two *pinnæ*, each division bearing numerous leaflets. The best way to make them work is to light a match and put it under the end pair of leaflets at the tip of one of the *pinnæ* of the leaf. The first pair of leaflets then shut, then the second, and so on till the whole *pinna* is closed; the same stimulus then closes the two leaflets next the stalk of the neighbouring *pinna*, and the leaflets close one after the other till the tip of the leaf is reached. Every leaf on the same branch follows suit. After some time the leaf-stalk falls, another leaf closes in the same way, until the effect of the stimulus is at an end. These photographs are taken as quickly as possible consistent with giving the right exposure, and require a whole plate.

A second plate shows the leaves reopening, taken at intervals of about five minutes; the exposures were continued until the leaves shut into the sleep position for the night.

The more common species, *M. pudica*, serve equally well for experiment.

Climbing Plant (*Mucuna nivea*).

Fig. 27.

Fig 29.

Fig. 26.

Fig. 28.

Figs. 26 and 27.—Photographs. Show the tip of the stem turning round the support.
Fig. 28.—Photograph. Shows the same tip appearing on the other side of the support.
Fig. 29.—Photograph. Shows the tip applied closely to the support.

The Weather Plant.—*Abrus precatorius.*

There has been much discussion about this plant lately as to whether it really predicts the weather to be expected in the future. I have a series of photographs extending over one complete day, which show the regular day and night movements of the plant. The plant was kept in a glass case sheltered from wind and sun at a temperature not below 73° F. = 22·5 C. The plant was placed with the rachis (midrib) of its youngest leaf facing north. The photograph was begun at 11.30 a.m. on Thursday, March 31, 1904, and continued until 10.30 p.m. It takes up the sleep position at 4.30 p.m. Then the photograph was begun again at 5 a.m. on April 1, while the leaves were still shut. As the sun rises the leaflets gradually open, and each leaf raises itself so quickly that one can watch the movements easily.

The kinematograph seems to afford a means of definitely settling this question. The photographs give an unbiassed record of the movements of the plant and the weather reports, barometrical and thermometrical readings, records of earthquakes, &c., can be provided by the various meteorological stations, so that if a re-investigation is ever considered necessary after Professor Oliver's * exhaustive report on the subject the data could in this way be obtained.

Climbing Plants.—This is a very fascinating subject for the Kammatograph. One has to focus the support on which the plant is climbing and to keep the tip of the climbing stem in the field. As the plant grows in length the Kammatograph has to be raised. In showing the photograph with the lantern a jerk will be noticed every time this is done, so if it can be arranged to alter the stand every morning one can see how much the plant has twined each day. Anyone who takes the trouble to photograph a climbing plant will be surprised at the very curious movements of the tip. The way in which it circumnutates, turning to every point of the compass, then gives a twist when it comes into contact with its support, is very fascinating.

The real difficulty with the climbing plant is that it grows and climbs just as much at night as it does in the day, so that if it is not photographed at night there is an interruption when projecting it with the lantern corresponding to the beginning of each new day. I am afraid a perfect photograph of a climbing stem will not be attained without clockwork apparatus, as the trouble involved of sitting up all night for at least a week would be too much to expect, even of the most ardent photographer.

The plant illustrated is a Calcutta stem-climber, *Mucuna nivea*. It was photographed for a week from 6.30 a.m. to 11.30 p.m.

I hope in these few pages that I may have succeeded in interesting some of the readers of "KNOWLEDGE" in the work of making animated pictures of plants, and shall be only too glad if I can be of any use to anyone who wishes to try these experiments. The illustrations of such a subject are naturally disappointing, as they cannot appear animated, but if anyone will take the trouble to cut out the ten figures of the opening bud of *Sparmannia africana* (Figs. 1-10) and paste each on a card or luggage label, and fasten them together closely at the lower end, by letting each figure pass before the eye they will appear animated and will give some rough idea of what the plate will show when projected with a lantern.

* Kew Bulletin, Jan., 1890.

The "Canals" of Mars.

A Reply to Mr. Story.

By E. Walter Maunder, F.R.A.S.

Several correspondents having expressed a strong wish that I should give some reply to Mr. Story's letter on this subject, I will endeavour to do so; not without reluctance, as the line which Mr. Story took seemed, in my opinion, hardly likely to advance our knowledge.

If I may briefly summarise Mr. Story's objections to the paper communicated by Mr. Evans and myself to the Royal Astronomical Society last June, they come under three heads. He objects to me as the author, to the methods employed, and to the deductions drawn.

The first objection is of course a somewhat delicate one for me to handle. It deals rather with the personal than with the scientific, and I have no inclination to fill the columns of Knowledge with detailed evidence of my claim to be considered an "expert" on the subject of Mars. Let it suffice that as long ago as 1877, I had made a thorough study of the planet, using the fine $12\frac{3}{4}$-inch Merz refractor of Greenwich Observatory. In 1892 and 1894 I also used the 28-inch Grubb refractor - certainly one of the most perfect objectives in existence. I give two or three examples of my earlier drawings, from

Fig. 1.—Drawings of Mars made with the 12¾-inch Refractor of the Royal Observatory, Greenwich.

			H. M.				H. M.
1.	1877	September 29th	[illegible]	2.	1877	September 24th	[illegible]
3.	1879	November 5th..	[illegible]	4.	1882	January 9th	[illegible]

which it will be seen that I had recorded some of the markings now familiar to us as "canals" and "oases," even before Schiaparelli had published his results, and quite a number before they had been generally recognised by observers.

So much for the person, next for the methods. Mr. Lowell and Mr. Story both appear to object to the employment of terrestrial experiments to elucidate planetary appearances. Mr. Lowell's opinion to this effect may be found in his letter published in the "Observatory" for January, 1904, p. 50: "Permit me, in conclusion, to point out to you . . . that the only evidence germane to the matter is to be got from astronomical observations directed to that end." But as Mr. Story points out, Mr. Lowell himself has set on foot terrestrial experiments for the express purpose of drawing inferences with respect to his observations of Mars, and Mr. Story approves of his so doing. Eliminating what is common to the two cases, the one of which meets with Mr. Story's approval, and the other with his disapproval, the only residuals are Mr. Lowell on the one hand and myself on the other, and the statement is reduced to the simple proposition that he approves of Mr. Lowell and disapproves of me, irrespective of our actions. In other words, his second objection is but a more diffuse way of restating his first.

But to take the matter seriously, let us see precisely what is the point where Mr. Lowell's views and my own diverge. It is not in the chief markings of Mars. Mr. Lowell sees and draws these substantially as I saw and drew them in 1877, and as Beer and Madler drew them in 1830. It is not in respect to the appearance of the "canals": I observed and drew "canals" as far back as 1877, and though of course Mr. Lowell has seen and drawn far more "canals" than I have, those that I saw were substantially of the same character as his; and in the discussion of this question I have been most careful, both in writing and speaking, always to point out that I was not throwing doubt either on the fidelity or the skill of any of the observers of Mars. Mr. Evans and myself wrote: "It would not be in the least correct to say that the numerous observers who have drawn 'canals' on Mars during the last twenty-five years, have drawn what they did not see. On the contrary, they have drawn, and drawn truthfully, that which they saw." ("Monthly Notices" Vol. LXIII., p. 499.) Nor have I ever asserted or assumed "that the canals are seen as very faint lines, so faint that their existence is doubtful even to experienced observers." I know the reverse by actual experience.

We agree on a third point. Mr. Lowell is absolutely convinced, and in this I am quite at one with him, that it is not possible that an actual network so geometrical as that which he represents can be the result of purely physical causes. Mr. Story has no doubt seen the very fascinating book which Mr. Lowell published on "Mars" in November, 1895, and has read the pages 148-154.

After this we differ. Mr. Lowell attributes this confessedly utterly unnatural network to the handiwork of intelligent beings who have woven over their planet these "grotesque polygons" to use Schiaparelli's expression.

This, be it noted, is inference, not observation; and an inference which demands the assumption that, were Mars brought much nearer to us, or our power of seeing greatly improved, these grotesque polygons would still persist, and would never resolve themselves under better seeing into markings which we could reasonably ascribed to the unaided processes of Nature.

My inference is different; the unnaturalness may be due to the imperfection of our seeing. I rely on well-known facts respecting the theory of vision and the structure of the eye, and the eye is our necessary instrument for observation. We have no right to resort to the unknown and the artificial, before we have exhausted

the known and natural methods of explaining a phenomenon. My inference is one based on the observed effects of known causes: Mr. Lowell's inference is an excursion into fairyland.

We know that the smallest single dark marking on a bright ground which can be seen by an observer of perfect sight, without optical assistance, must have a diameter of at least 34 seconds of arc. This diameter depends upon the size of the rods and cones of the eye which receive the visual impression, and compose the sensitive screen. It is therefore an inevitable limit. As this diameter is necessary for the object to be merely perceived, or, in other words, to create any sensation at all, it follows that in order that the actual shape of the object may be recognised, its diameter must considerably exceed this limit, otherwise it will be seen as a truly circular dot, whatever its actual shape.

This is the case for small isolated markings just within the limit of visibility. The case is different for extremely elongated markings; the increased length of a marking will compensate for diminished breadth up to a certain limit, but not beyond it. For a line of indefinite length the limit of breadth approaches two seconds of arc. A line of a breadth below one second of arc is invisible, no matter what its length; but it must have a breadth many times this amount before it can be seen as anything else than a mere line—before irregularities in shape and breadth can make themselves apparent.

In naked-eye vision, therefore, there is a considerable range within which small objects, whatever their true shape or nature, can only be seen as dots or as lines. The result is that these two forms are certain to come in evidence whenever we are dealing with objects too minute to be fully and properly defined.

The problem becomes more complicated when we are using optical assistance, as there is a limit of definition belonging to the telescope as well as to the eye. But the principle remains the same; the result of adding the limitation of the telescope to the limitation of the eye being that the actual magnification of the telescope can never be nearly as effective as it is nominally. A power of 300 on the best telescope in existence, and under the best atmospheric conditions, would never show the features of the moon as distinctly as they would be seen if the moon were brought 300 times as near.

Mr. Story and Mr. Lowell both object that terrestrial (or, as they are more usually called, "laboratory") experiments are altogether beside the mark when applied to the interpretation of astronomical observations. The contention is a ridiculous one, and if logically applied would render it impossible to determine the instrumental errors of a transit circle by the use of meridian marks, collimators, or mercury trough, or the personal equation of an observer, except by actual stellar observation. They would also forbid us to identify the lines of solar or stellar spectra by comparison with those of any terrestrial element.

But since it is contended that Mars alone can give us valid information on the subject, to Mars let us refer. If we turn to the drawings made by Beer and Madler in 1830, two small objects exceedingly like one another appear repeatedly. These are two dark circular spots, the one isolated, the other at the end of a gently curved line. Both recall the "oases" which figure so largely in many of Mr. Lowell's drawings, and the curved line at the termination of which one of the spots appears, is not unlike the representation which has been given of several of the "canals." There can be no doubt that in the year 1830 no better drawings of Mars had appeared than those to which I have referred, and that in representing these two spots as truly circular Beer and Mädler portrayed the planet as they best saw it. The one marking we call to-day the *Lacus Solis*, the other the *Sinus Sabæus*, and we can trace the gradual growth of our knowledge of both markings from 1830 up to the present time. The accompanying sketches of the same region

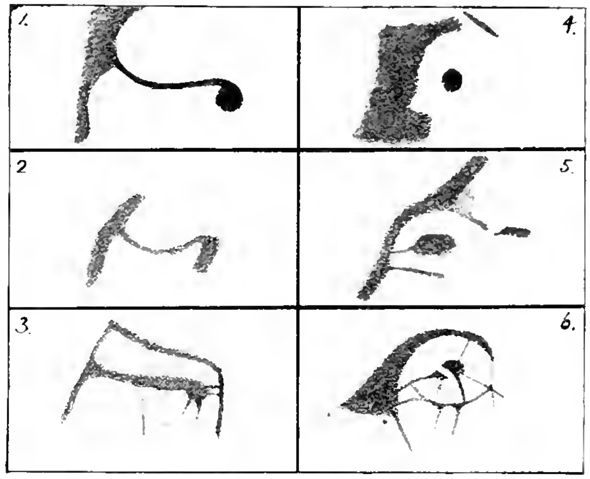


Fig. 2.—Sinus Sabæus and Lacus Solis.

1.	Sinus Sabæus..	..	Beer and Madler	1830.
2.	" " ..	..	Lockyer ..	1862.
3.	" " ..		Schiaparelli ..	1890.
4.	Lacus Solis ..	..	Beer and Madler	1830.
5.	" " ..	..	Lockyer ..	1862.
6.	" " ..	..	Schiaparelli ..	1890.

by Lockyer, in 1862, and by Schiaparelli, in 1890, illustrate well how the character of the markings revealed themselves with increased telescopic power and experience in the observer.

> "At first it seemed a little speck
> And then it seemed a mist,
> It moved and moved and took at last
> A certain shape I wist.
> A speck, a mist, a shape."

If Beer and Mädler, in 1830, had argued that the precise circularity of these two spots, as they appeared to them, was proof that they were artificial in origin, would they have been correct? Would not the answer have been valid that a spot too small to be defined must appear circular, and that, therefore, the apparent circularity probably covered detail of an altogether different form? We know that it would. Yet it is that same argument in a far stronger form against which Mr. Lowell and Mr. Story are contending to-day. Beer and Mädler only drew two of these spots; Lowell shows over sixty. Beer and Madler's two spots seemed to them precisely alike; how utterly different those two spots appear to us to-day the diagram may serve imperfectly to indicate. Mr. Lowell's sixty or more "oases," with one or two exceptions, appear all of the same character. Will anyone dream that if the next seventy years brings telescopic development equal to that shown in the last seventy, the present uniformity of Lowell's "oases" will persist, any more than the likeness of the two spots observed by Beer and Madler? We need not even wait for the seventy years. Up to the present moment I have carefully avoided anything like criticism of the drawings of any observer of Mars. I have repeatedly stated that I accepted them as being both faithful and skilful representations of what the observers saw. But it is necessary here to point out that the extreme simplicity of type of

both "canals" and "oases," as shown by Mr. Lowell, is not confirmed by the best observers. In the last number of "KNOWLEDGE" Mr. Denning writes (p. 67): "There are really many distinctions in the canal-like markings; some of them are quite broad and diffused shadings, while others are narrow, delicate lines." The Rev. T. E. Phillips has recently insisted strongly ("Monthly Notices," Vol. LXIV., p. 40) on the same fact, and I could increase the testimony indefinitely. There can be no doubt that the best observers not merely agree in stating that the "canals" differ very widely in their characteristics, but they also agree closely in the characteristics they assign to special "canals." With regard to Lowell's observations I can, of course, speak only with reference to those which he has published, but speaking with reference to these there can be no doubt that he fails to exhibit that wide variation in character between certain "canals" upon which these and other leading observers are fully agreed. This seems to me clear proof (so far as his published drawings go) not of superior conditions and skill on Mr. Lowell's part, but of a most marked inferiority in one respect or the other. Whether it be the location of his observatory that is at fault, or the definition of his telescope, or his own personal skill in observation, or most probable of all, in delineation, the fact remains that despite the multiplicity of his observations and the perseverance, which cannot be too highly praised and too fully recognised, with which he has observed Mars in season and out of season he has failed to record differences apparent to a consensus of other first-rate observers. Especially he has failed to recognise what Denning and Schiaparelli had recognised as early as 1884, that many of the "canals" were very far from being straight lines of uniform breadth and darkness, but showed evident gradations in tone, and irregularities occasioning breaks and condensations here and there. Of all the thousands of drawings of Mars which I have examined, those that most perfectly corresponded to Mr. Lowell's were the work of a young novice and were made in by no means an ideal station, using a small home-made telescope.

It is made an argument in favour of the actuality of the "canals" that they have been seen with such distinctness, or with such frequency. The argument is based upon a very complete ignorance of the appearance of the fictitious "canals" observed in the experiments made by Mr. Evans and myself. I have myself been completely taken in by a little drawing on which the Syrtis Major and Sinus Sabæus were shown. As I looked at it by far the most insistent feature was a straight, narrow, intensely black line corresponding to the Phison. Yet that astonishingly vivid impression was really due to the integration of two or three feeble lines, irregular, broken, and serpentine curves, and half a dozen utterly invisible dots. If I had looked at that drawing a thousand times, or if a thousand other observers had examined it under the same conditions as to distance, they could only have seen what I saw—a dark, straight line, as sharp as if cut by a graving tool.

The change in the distinctness of the "canals," consequent on the progress of the Martian seasons, was no discovery of Lowell's; the fact was realised by Schiaparelli very early in his observations. But so far from rendering it more probable that the "canals" indicate artificial water-ways, it affords a most serious argument against their having that character. For water cannot flow uphill, yet the water from the melting polar snow, according to Lowell, must flow upwards to reach the equator. If, with Lowell, we consider the dark markings on Mars to be vegetation rather than water, they would change in appearance with the seasons whether they were of natural origin and irregular shape, or were artificial and symmetrical; and Mr. Lowell's 8500 observations do not increase the probability of his theory more than 85 or 8½ would do. A "canal" or an "oasis," if seen only as a straight line or a circular dot, that is to say, if seen only in the simplest possible form, affords no proof that the precise form under which it appears has any actuality. It is only when the object begins to show detail that we are sure that we are beginning to see it as it is. And one of the most convincing testimonies that Mr. Evans and myself have been following the right line has been shown by the attitude which the most experienced observers of Mars have adopted towards our inquiry. They have claimed, as Mr. Denning did in last month's "KNOWLEDGE," that certain "canals" are undoubtedly real, for they have been resolved or partially resolved into minuter details, being "composed of small, irregular condensations." Others they have admitted may be "canals" only in appearance, being actually either "the edges of half-tone districts or the summation of very minute details." In both the claim and the admission they are in perfect accord with the position held by Mr. Evans and myself. On the other hand, Antoniadi, Barnard, Denning, Molesworth, Stanley Williams, have all held themselves aloof from the bizarre delineations and yet more bizarre theories which Lowell has promulgated. Most striking of all, Mr. W. H. Pickering, who preceded Mr. Lowell in his argument that the water supply in Mars is restricted, and in the recognition of the system of "oases," who further has had the opportunity of observing with Mr. Lowell's telescope and in the climate of Arizona, has not only frankly accepted our position, but has supported it by direct photographic proof. Mars, unfortunately, does not lend itself to photography, but the Moon does; and Mr. Pickering has found confirmation of our experiments as to the building up of straight-line systems from imperfectly seen details by comparing his drawings of certain lunar formations with actual photographs.

Stimulus and Sensation

By J. REYNOLDS GREEN, Sc.D., F.R.S.

IF we contemplate the enormous variety of form and structure which we find to exist among plants, and endeavour to study the reasons which we can readily trace for the diversity in these respects, the conviction is forced upon us that the story which is hidden there is one of stress and struggle, the result being a correspondence between the plant and its environment, so that the former can take advantage of all that is offered to it by the latter, and can resist successfully such deleterious influences as are inevitable from its situation. Hence different environment entails different structure. Moreover, as the environment is continually changing in some respect or other, the organism is continually involved in the struggle to adjust itself to the alterations thus besetting it. In the absence of power to maintain satisfactory relations, the plant becomes unhealthy, and after a time it perishes. Health, indeed, is but the expression of a satisfactory equilibrium gained and maintained between the plant and its surroundings.

As we cannot deny the extreme probability, perhaps we may say the certainty, that all plants now living have been descended from some primitive form, we can find in the history of different races the enormous effects which long-continued struggle for successful adaptation to a changing environment can achieve. The effect of change upon a single individual may be, indeed, must be, slight; but long-continued influence upon long series of descendants brings about a marked cumulative effect, and though we see little change in a generation, we are obliged to admit relatively enormous modification in the course of time. But though we can see little alteration in the individual, we may argue backwards and realise that no great change could occur in a race except by modifications of successive individuals of it. We must, therefore, look minutely to the individual to see what the properties are which in long years can effect such modifications of both form and structure as we find.

We have then to study what we may call the adaptation of the organism to its environment. At the outset, we must admit that such adaptation can take place only in two ways. Possibly, all plants whose constitutions are not in harmony with the changed conditions will perish, leaving more fortunate ones to carry on the race. This postulates that the plants of any particular generation are themselves varying slightly in their physiological properties. Possibly, on the other hand, the individual organism is possessed of a power of appreciating changes in its surroundings and of modifying its own behaviour accordingly. It may well be that both these hypotheses are to a certain extent true, and that they are co-operating to bring about the results we see.

There are strong grounds for accepting the latter of the two views as playing a very prominent part in the changes of the past. We can see certain phenomena occurring under our own eyes which are capable of interpretation in the way suggested, which, indeed, are inconsistent with any other hypothesis. A plant acted upon by a certain definite external influence modifies its way of behaviour in an equally definite manner. It is difficult to deny to the plant the power of perceiving the influence brought to bear upon it. The effect of the influence is technically called a *stimulus*, and the perception of a stimulus by the plant is known as a *sensation*. We have two factors then to consider, one external, the other internal, to the plant.

A more complicated question arises here. Is the perception of a stimulus, is a sensation, to be interpreted as implying any kind of *consciousness*? We have a stimulus, we have a response. What can we say of the interpretation of the one by the plant which makes it bring about the other? The problem is very difficult to speak with confidence upon in the present state of knowledge. The human mind shrinks at once from taking the affirmative view. No doubt, in the higher sense in which we interpret the word, no consciousness can have part in a vegetable organism, for this sense implies *thought*. It is difficult to suggest that a purposeful response implies any kind of volition. These operations are the immediate functions of the well-organised and most highly-developed nervous centres of the highest animals. But certain facts can be adduced which, at any rate, hint at the existence of such a limited consciousness as implies an appreciation of the nature of the surroundings.

To discuss this question at any length would, however, take us beyond the purpose of this article. We must confine ourselves to the question of stimulus and sensation as far as we can see them both at work in the course of ordinary vegetable life, leaving the full interpretation of the relation between them to be set aside for the present.

The nature of a stimulus first concerns us. We may take it for granted that there may exist for every plant, at any rate theoretically, a condition of adjustment when it is in absolute harmony with its environment—when temperature, illumination, moisture, rest, and whatever else affects it, are perfectly as the organism wants them, and when consequently its life is being regulated to the utmost advantage. Such a condition can be only momentary in any case, for the surroundings are in a constant state of change in many of these particulars, and the living substance of the plant is also exhibiting continual motility. For the maintenance of health, or even of life, it is essential that variations in the one shall be adequately responded to by variations in the other. The impossibility of securing indefinitely such a continual adjustment of relations is the cause of the cessation of life.

Such an alteration of the environment constitutes a *stimulus*. It may affect the plant in a hundred ways, causing various methods of response, and various degrees of intensity of response.

There are, however, other factors influencing its life which are not so easily realised by observation. Changes may arise in the condition of the living substance of the plant, set up perhaps by disturbances in its interior. The normal cause of chemical change associated with the nutritive processes may undergo a marked change in consequence of an alteration of the distribution or the direction of the stream of food in the plant's interior. Injury to the body of the plant may involve a re-distribution of energy or of material within it, which may have far-reaching effects upon the course of the vital processes. Variations in the supply of food, which may range between absolute starvation and over-engorgement, may produce very great changes not only in the outer life of the plant, but in the substances it produces in the course of its nutritive processes, and in the energy which it liberates. An insufficient supply of oxygen may provoke an almost entirely new series of chemical changes in connection with the production of such energy. These various factors and many others which might be quoted are to be regarded as stimuli, some of them internal no doubt, but all equally real and equally well appreciated by the plant as the more obvious external ones just described. Even more obscure stimulations may arise from chemical changes in the living substance itself, leading to a series of responses which, as they do not appear immediately related to visible stimuli, are often called automatic.

To appreciate more fully the part played by stimulation in the life of a plant, we may briefly consider a few of its more obvious forms. Consider the lateral incidence of light upon a growing seedling or young plant. If the latter is placed so that one side of its stem is more brilliantly illuminated than the opposite, a curvature soon appears in the part that is actively growing. This is of such a nature and takes place to such an extent as to cause the axis of the plant to take up a position in which it is parallel to the direction of the incident rays. It manifests itself in some cases very slowly, in others comparatively rapidly. This response to the stimulus of unequal illumination on its two sides is not confined to the stems of seedlings, but may be seen to a greater or less degree in parts of many adult plants. It is a matter of common observation that geraniums grown in a window all bend their stems and petioles towards the illuminated side.

In other cases the same stimulus may be responded to in quite a different manner. When certain young roots are exposed to it they curve so as to place themselves in the same position with regard to the incident rays, but with their growing apices in the opposite direction. Various tendrils, peduncles, and other organs respond in a similar manner. Leaves tend to place themselves across the incident rays.

Among the obvious difficulties which beset the course of a root in making its way through the soil is that of impinging more or less directly upon some particle which it is unable to displace. In practice it is nearly always found to be able to grow past such an obstacle. The situation affords us another example of stimulus appreciated and responded to. Contact with the apical portion of the young root causes an immediate departure from the straight line of growth. The behaviour of the organ can be studied on a germinating bean with great readiness. If such a structure be kept in moist sawdust till the young root emerges, then be transferred to a moist chamber and suspended therein, a small piece of hard substance, such as card-board, can be attached by a little cement to the side of the lip. The root at once begins to curve away from the side thus touched, and if the stimulation is maintained for some time the resulting growth will cause the root to grow into a loop. If a tendril of *Passiflora gracilis* have a small loop of thread laid upon a certain portion of it, it will curve at once and in about two minutes will assume the form of a helix. Other tendrils behave in a similar way on coming into contact with different hard supports, though the rapidity of their response varies considerably.

The nature of the response must, however, be considered before we can associate it in any co-ordinated fashion with the stimulus. Such co-ordination between the two must be put in evidence if we may fairly deduce such an appreciation as we can call sensation.

The first thing that strikes an observer is the evident *purposeful* character of the response. The position assumed in relation to the incidence of the lateral light is that which will ensure an equal illumination of the surfaces of all the leaves. These spread out at approximately equal angles with the stem in all its sides, and hence when the stem is parallel to the light source the greatest amount of sunlight falls upon the green surfaces of the plant, where the work of forming sugar under the influence of such light is taking place. The opposite effect produced upon roots is calculated to press them closely into the soil, where their absorbing hairs can have free play. The curvature of the tendril assists it to secure a holding for the plant, so that its weak stem escapes being trodden down and its leaves are enabled to reach light and air.

A less obvious consideration is afforded by the fact that the parts of the plant receiving the stimuli are in cases strictly localised. The receptive part of a root is just behind its apex; that of a young seedling stem is in about the same position. Not only is this part localised, but it is situated in quite a different part from that which effects the movement. The latter is caused by growth some half-inch or so nearer the base, at a part which is quite insensible to stimulation.

Another consideration which bears upon the question is that an extremely small stimulus is able to bring about a very considerable effect, and that there is no simple ratio between the intensity of the stimulus and the extent of the response. An instance of this is afforded by the behaviour of the tendril of *Passiflora* already described.

We can, therefore, associate stimulus and sensation and point to the response of the plant as evidence of both.

Saturn.

At the beginning of May Saturn rises $2\frac{1}{2}$ hours before the sun and telescopic observation may be renewed, though the planet will scarcely be far enough west of the solar orb to be presented under very satisfactory conditions. The ensuing apparition of this attractive object is likely to prove of great interest. His southern declination will be 3° less than it was last year and this ought to bring about an improvement in the definition.

In the summer of 1903 Saturn displayed the evidences of considerable activity in a number of bright and dark spots, of irregular form, distributed in about N. lat. 35° along the polar side of the northern equatorial belt ("KNOWLEDGE," Dec. 1903). In June, July, and August these markings were frequently seen, though but few observers appear to have retained them in view during the autumn months. The rotation period of the chief spot or spots was variously determined as follows:—

Observer or Authority.	Period. h. m.	Days of Observation.	Reference.
K. Graff ..	10 39.01	3	*Ast. Nach.* 3883.
J. C. Solà ..	10 38.4	32	*Ast. Nach.* 3894.
P. Fauth ..	10 38.0	18	—
*E. E. Barnard	10 38.8	40	*Ast. Journ.* 547.
L. Brenner ..	10 38.0	40	*Ast. Rund.* 47. *Observatory* 336.
	h. m. s.		
H. W. Wilson	10 38 4.8	75	*Popular Ast.* 108.
*G. W. Hough ..	10 38 27	53	*Monthly Not.* Dec., 1903.
*G. W. Hough ..	10 38 30.5	24	*Monthly Not.* Dec., 1903.
†W. F. Denning	10 37 56.4	129	*Monthly Not.* Jan., 1904.

* In these cases the identifications were uncertain and the resulting periods probably excessive.
† Mean value derived from observations of 18 spots.

As soon as Saturn can be successfully examined it will be important to ascertain whether the markings continue perceptible. Possibly, at the present time, the northern hemisphere shows nothing more than the beautifully symmetrical belts and zones which usually stripe the disc. The material of the differently tinted irregularities seen in 1903, which probably resulted from extensive eruptions affecting the atmospheric scenery, may have amalgamated with the ordinary bands of the planet and quite lost their distinctive outlines. And the region affected may remain quiescent for a time to be again disturbed by further outbreaks in the near future. The phenomena occurring on Saturn are, no doubt, very similar to those visibly taking place on Jupiter, and observation has taught us that on the latter planet one disturbance scarcely subsides before another forces itself into prominence. The spots common to certain latitudes of Jupiter possess some physical resemblances, and are characterised generally (though not invariably) by nearly identical rates of motion, according to the longitudinal current in which they are placed. The same thing is likely to be displayed on Saturn, and the few following years may be expected to furnish useful evidence on this point.

The spots on Saturn remained fairly conspicuous objects in December, 1903, and observers will probably redetect them during the present spring. If so, it will be desirable to obtain as many transits as possible, so that the individual objects may be satisfactorily identified and their periods of rotation redetermined.

The markings referred to certainly exhibited some of the vagaries which occasionally affect the features on Jupiter, for the rate of their motion underwent a decided acceleration at the close of the apparition. Several of the principal objects which, during the summer, gave a period of 10 hrs. 38 min. 3 sec. conformed with a shorter period of 10 hrs. 37 min. 50 sec. during the latter part of the autumn.

In regard to Saturn, the year 1903 will be remembered as one of considerable historic interest, for the rotation of the north temperate region was found to be $23\frac{1}{2}$ minutes greater than that derived by Professor Hall from his equatorial spot of 1876, and the fact rendered conclusive that this planet, like Jupiter, displays atmospheric spots affected by large proper motions.

Mr. Crommelin's "Ephemeris for Physical Observations of Saturn, 1903-4" (*Monthly Notices*, December, 1903) will be found extremely useful in the further study of this interesting object.

W. F. DENNING.

The Double Stereoscopic Projection of the Eight-Cell.

By G. H. BRYAN, Prof. Sc. D., F.R.S.

IN connection with Mr. Benham's paper on "The Super-Solid," it will be noticed that the diagrams of pairs of connected cubes, even when seen through a stereoscope, fail to convey the impression of being the projections of a *regular* figure.

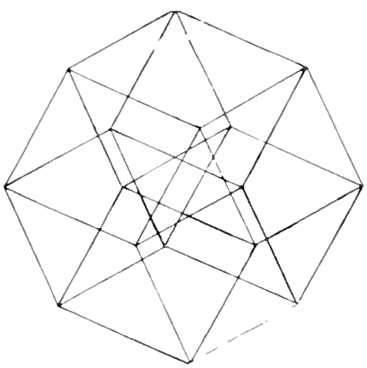
A much better idea of the regular character of the "super-cube" or "eight-cell," as it is called by most writers, and of its connection with four-dimensional space can be acquired by choosing the plane of projection in such a way as to give the diagram a more symmetrical form, and by using two different stereoscopic projections instead of one.

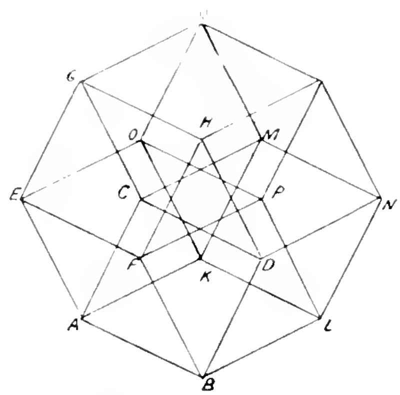
In fact, if the first stereoscopic view represents the projection of a four-dimensional "eight-cell" in a solid space containing the first, second and third dimension, the other view represents the aspect of the same "eight-cell" projected in a space containing the first, second and *fourth* dimension.

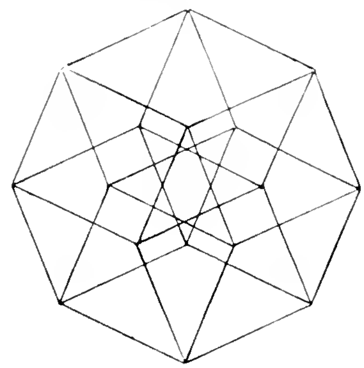
Either of the two aspects shows a solid figure, which is *symmetrical* but not perfectly *regular*. It is not difficult, however, to convince oneself that the four-dimensional figure of which the two aspects are simultaneous projections is regular.

In regard to the fact that in either view two of the vertices (not the same two) appear *inside* the solid projection, a comparison of the two aspects will show that they are not really inside, but only look so owing to the direction of projection. This property is exactly analogous to the fact that if we draw the trace of a cube by projection on a plane, the projections of two of the vertices will be inside the polygon formed by the projections of the remaining vertices. It is only when the cube is viewed as a solid, or studied by means of its projections on *different* planes, that we become aware that all the vertices lie on the boundary of the cube.

A complete account of the regular figures possible in four-dimensional space, corresponding to the five regular solids enumerated in our text books of elementary solid geometry, is given by Mr. S. L. Van Oss in the Transactions of the Amsterdam Academy for 1899. The largest number of faces a regular solid can have is 20, the figure being known as an icosahedron, but in four-dimension space, the maximum number of boundaries is 600, and the projections of the "600 cell" shown in Mr. Van Oss's diagrams are very beautiful and symmetrical.







In the annexed series of diagrams the central figure represents a symmetrical plane projection of the "eight-cell." It is not the only projection which is symmetrical, but it is a convenient one in which the edges and sides are well separated, and are nowhere near overlapping inconveniently.

When this figure and the figure to the left of it are viewed together through a stereoscope, the lines will stand out in relief, giving the impression of forming a solid figure in which the point H is nearest the observer, and K is furthest always. The points C, P appear to be *inside* the solid, and to be in the straight line joining E and N.

Now let the central and the right hand figure be brought into view in the stereoscope, and it will be observed that the whole aspect of the figure has altered. This time P is at the front of the figure and C is at the back, while the points H and K which were previously the nearest and furthest points appear to be inside the figure in the straight line joining Q and B.

As the same central figure is used in both cases, the traces of the two stereoscopic solids on the plane of the paper are, to all intents and purposes, the same. If, as assumed they both represent different aspects of the same figure the *distances* of the different points from the plane of the paper in the first place must be entirely independent of the distances from the plane of the paper in the second case. *These distances therefore correspond to different dimensions of space.*

An interesting variation of the experiments described in this paper may be made by cutting out the two extreme figures and placing them simultaneously in the stereoscope, then inverting one of them and again placing in the stereoscope. In this manner two other aspects of the eight-cell will be seen. The scale of stereoscopic relief will, however, be different to what it was in the previous observations, but this will not much matter.

N-rays and Smell.

THE controversy concerning the objective reality of the N-rays suggests that to the proverb concerning the difficulties of accounting for taste, we shall have to add other maxims about the difficulties of accounting for sight and smell. On the one hand, M. Blondlot, Professor Charpentier, and M. Edouard Meyer continue in their respective spheres of investigation to add new facts each week—by means of papers read before the Académie des Sciences—to the common knowledge of the N-rays. On the other hand, Professor J. G. McKendrick and Walter Colquhoun, as well as other observers in Great

Britain, have failed to find any trace of the rays as objective realities; Professor C. C. Shenck has criticised, in a way which demands an answer, M. Blondlot's experimental methods and his alleged measurement of the N ray's wave length; and Herr O. Lummer has suggested, in a paper read before the German Physical Society, that the observed phenomena are due to processes in the retina of the eye ("the contest between the rods and cones of the retina"). Meanwhile, the French observers go on undismayed by the stain of criticism and objection, and in *Cosmos* (April 2) Professor A. Charpentier gives the result of his observations on the connection between N rays and the sense of smell. The N rays, he observes, exercise a very distinct action on the olfactory sense. It can be shown if the nose is approached during the action of smelling by a body capable of producing N rays, such as a piece of tempered steel or the closed fist, that the sensation of smell is increased. The experiment must be made with all necessary precautions, in still air, very slowly, with gentle and regular breathing, the odorous substance being maintained at a fixed distance nearly approaching to the extreme limit at which the olfactory organs can perceive it. The source of N rays can either stimulate the sense of smell when the limit of perception is almost reached, or increase its intensity where it is already in existence. In both cases, the action is perceptible. It takes place when the source of the rays is approached to the root of "the nose or the base of the nostrils." If the mass of muscles in the thumb are placed against the nose, the slightest contraction of these muscles produces the effect already mentioned. Essence of cassia was the odorous substance usually made use of by Professor Charpentier, but the same results have been obtained by him from very different scents—essence of lavender, thyme, cloves, mint, camphor, ether, iodoforme, ammonia, and acetic acid among them. The N-ray action penetrates thin sheets of aluminium, and it is useful in order to eliminate the currents of air produced, in spite of all precautions, by displacing the source of the rays, to place a large sheet of this metal against the outside of the nose, and to conduct the experiment on the other side of it.

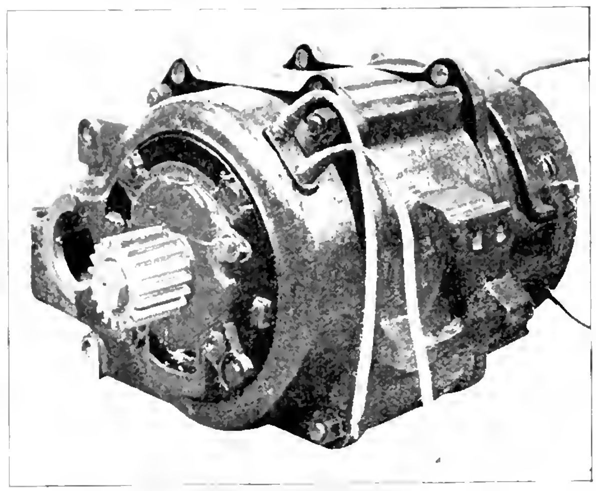
N-rays can, moreover, influence the olfactory sense when they are made to act at certain points on nerve centres if, for instance, the substance, which is the source of the N-rays, is placed near the middle of the forehead immediately above the place where the eyebrows meet. The effect is especially striking when the source of the rays is placed on the summit of the cranium a little in front of the place of union of the frontal and the two parietal bones.

This effect of N-rays is not confined exclusively to the organs of perception. The scent is increased to some extent when the radiating source is put near the flask containing the odorous substance at too great a distance from the nose to influence it directly. Professor Charpentier continues: "In the same way I have observed that the substances thus mentioned distinctly emit N-rays which traverse cork, and aluminium, but are stopped to a great extent by lead, and can give rise, like the other sources, to secondary radiations. As for the action of N-rays on the other senses, I have found, to begin with, a very distinct effect on the sense of taste. If a trace of some highly flavoured substance is put on the end of the tongue such as camphor, aloes, salt, or sugar, keeping the mouth open, the breath held, and the palate raised so as to avoid all olfactory influence, the approach of a radiating source, such as a ball of tempered steel, reinforces or creates the sense of taste. The same thing happens when salt or other substance is diffused in the mouth instead of keeping it on the end of the tongue. Are there points of the brain on which N-rays can act by determining an increase of the sense of taste? After experiments with different parts of the cranium, I have only found a certain degree of action in one parietal zone, next to that which acts on vision, perhaps a little behind it. The study of hearing is more difficult, because of the precautions to be taken in order to prevent the currents of air displaced by breaking the source of radiation interfering with the conditions of arrival of the sound. It can be done, however, by making use of secondary radiations. Now, in taking as the source of sound a watch held at the extreme distance at which the sense of hearing can perceive it, I have only clearly proved some increase of sound when the terminal plate was placed right above the ear at 7 to 8 centimetres from the orifice of the ear, which appears to confirm the idea of an excitation affecting the central centres of hearing.

The Single-Phase Motor in Germany.

The single-phase traction motor which has been designed by the Union Electric Company, Berlin, according to Winter and Eichberg's data, and which is being tried on the Johannisthal-Spindlersfeld suburban line, near Berlin, is thus described by our Berlin correspondent:

The motor includes a stator similar to those of ordinary induction motors, containing a single phase coil arranged in notches, and a collector armature which is designed like the armature of a direct current motor, and to which two sets of brushes with axes perpendicular to one another are fixed. The first set, the axis of which coincides with the axis of the stator coil, is short-circuited. It carries the working currents proper. These are induced by the field ϕ in the direction of the axis of the stator coil of a series transformer that is inserted in the main-current circuit, and carries only magnetising currents. The magnetising currents produce a transversal field F perpendicular to the field ϕ, by which, in connection with the stator current, the efficient torque is produced. The presence of two separated fields enables the motor to work



Single-Phase Motor in use on the Spindlersfeld Railway.

without sparking. The electro-motive force generated in a winding that is short circuited by a brush through the induction of the field F is perfectly compensated as the speed of revolution increases, by the electro-motive force due to the rotation in the second field ϕ. That would be impossible in the case of monophase series motors, where, in the winding short-circuited through a brush, an electro-motive force independent of the number of turns, and incapable of being compensated, is induced.

Moreover, by the rotation of the armature, an electro-motive force is induced in the exciting circuit of the armature which is able not only to compensate perfectly the undesired electro-motive force of self-induction of the circuit, but at the same time the electro-motive force corresponding to the primary and secondary leakage. With an increasing number of revolutions the power factor will thus approach the value $\cos\phi = 1$, this value being maintained constant within wide limits on account of the unique regulation. Without any prejudice to motor efficiency, the air gap may therefore be made as great as in the case of direct current motors, and open stator notches may be used instead of closed notches. The ratio of the exciting transformer is regulated by the insertion or disconnection of windings. In the case of the series transformer being adjusted for a given ratio the motor will behave in a way quite similar to direct current series motors, both the current intensity and the torque having the maximum value at rest and decreasing for increasing angular speeds. In the case of the ratio of the series transformer being diminished, the characteristic curve of the motor is displaced so as to

have the same torque as previously observed with a given number of revolutions M_1 appear only at a number of revolutions M_2 (superior to M_1). The same number of revolutions will now correspond with a higher torque than before, the torque at rest being evidently also higher.

The motor is started by altering the ratio of the regulating transformer. The current of the excitor brushes being thus interrupted at rest, the primary coil of the series transformer will act as a reaction coil, and the whole motor will be traversed only by a very small current. It will thus be unnecessary to open the primary coil of the motor when stopping. It is sufficient to open the exciting circuit (low tension coil) because the motor works only in the case of the exciting circuit being closed.

The motors of the Spindlersfeld cars have an output of about 100 H.P. hours; they have four poles and a monolateral air gap of 3 mm. The total weight of a motor, including the small toothed wheel, is 2140 kg., the weight of the exciting current transformers common to both motors being 1100 kg. As regards the arrangement of the connections, the direct current multiple unit system of the Union Elektricitats Gesellschaft has been used and slightly modified. Two cars are being used in connection with the Johannisthal-Spindlersfeld trial runs, in addition to three trailers, each 16 tons in weight. The experimental trains are run on the same track as used for the regulation steam trains, and are inserted between the steam trains according to a fixed time table. The cars are designed for a maximum speed of 40 km. per hour, though speeds as high as 60 km. are sometimes reached. The motors have given full satisfaction even in the case of the highest strains, the whole train, including two motors and three trailers (155 tons), being often arranged and driven by the two motors only. The perfect independence with respect to the line tension has proved a special advantage as compared with the rotary current system, two-thirds of the line tension having been sufficient to maintain the regular service, while starting and running at a speed of about 30 km. was possible with 40 per cent. of the motor tension.

A. G.

Recent Explosions.

By CHARLES DAVISON, Sc.D., F.G.S.

INTERESTING evidence with regard to the propagation of sound by the atmosphere is afforded by the firing of heavy guns during reviews and sham fights, and by explosions in manufactories of dynamite and nitro-glycerine. Examples of the former class have been given in two recent papers.* During the great naval review at Spithead on June 26, 1897, held in honour of the late Queen's Diamond Jubilee, the sound of the first salute was heard as far as Weston, near Bath, at a distance of 71 miles. Again, on July 18, 1900, when the French President visited Cherbourg, a sham fight took place between two portions of the French fleet, giving rise to disturbances that were mistaken for earthquakes at many points along our southern coasts. The reports were heard from Dawlish and Exmouth on the west, to Brighton and Henfield on the east, the distance from Cherbourg to the latter place being 107 miles. Lastly, during the funeral procession of our late Queen, on February 1, 1901, the minute-guns were heard as far as Alderton, near Woodbridge, in Suffolk, which is 139 miles from Spithead.

In the present paper, I propose to describe similar evidence derived from two recent explosions, the first at Hayle, on January 5, of the present year, the second at Avigliana, near Turin, on January 16, 1900†.

The Hayle Explosion of January 5, 1904.

The works of the National Explosives Company at Hayle are situated on waste land, known as Upton Towans, about two miles north-east of Hayle and between three and four miles east of St. Ives. To reduce all risks to a minimum, the separate buildings are isolated as much as possible; and, to lessen the loss of life, in case an explosion should occur, the number of men employed in any building is always small. It was no doubt owing to the observance of these precautions that the loss of life during the recent disaster was comparatively slight.

At the time of the explosion (10.55 a.m.), nitro-glycerine was flowing down a gutter from the precipitating house to the filtering house, the latter lying about 400 yards north-west of the former. Only one man was working in the precipitating house and three men in the filtering house. It appears that the precipitating house was the first to explode, and that, owing to the temporary connection by means of the gutter, the filtering house followed immediately. This conclusion rests on the evidence of an eye-witness; on the fact that persons to the south-east of the houses heard two reports separated by from $1\frac{1}{2}$ to 2 secs., while those in the opposite direction heard only one; and on the condition of the gutter, which was not covered by the *débris* from the precipitating house. Both houses were, of course, destroyed, and their occupants killed instantaneously. As to the cause of the explosion, it can only be surmised—but the surmise is a probable one—that it was due to the fall of some heavy weight, either of one of the lead cups used to catch the droppings from the taps, or, more probably, of the lid of one of the tanks. In any case, the disaster must have been purely accidental in its origin.

The results of the explosion were visible for several miles around the works, chiefly in the breakage of glass. At Hayle, many windows were blown out. At St. Ives, the damage was estimated at not less than £200, but its distribution was partial, some houses suffering and others close at hand escaping; and it is worthy of notice, though the peculiarity has been recorded before, that the windows, especially in houses facing the works, were blown, not inwards, but outwards. Similar damage also occurred at St. Erth ($3\frac{1}{2}$ miles from the works), at Leedstown (4 miles), and, though to a much less extent, at Penzance (distant 9 miles).

A small oscillation of the ground was also noticed in the surrounding district. At St. Ives, according to my informant quoted above, the vibrations could not be distinguished from those produced by an earthquake. At much greater distances windows were shaken; but this must have been caused by air-waves. Observations of this kind were made at several places in Devon, at Ivybridge and Modbury (68 miles), near Torrington (74 miles), at Paignton (83 miles), Torquay (86 miles), and Teignmouth (88 miles).

The distribution of the places where the reports were distinctly heard is shown in the sketch-map in fig. 1. To the

Fig. 1.

* "The distance to which the firing of heavy guns is heard." *Nature*, vol. lxii., 1900, pp. 377-379; "On the audibility of the minute guns fired at Spithead, on February 1." *Knowledge*, vol. xxiv., 1901, pp. 104-105.

† For the account of the Hayle explosion, I have relied on the reports which appeared in the *Western Morning News* (Plymouth), and on replies to a letter which the Editor of that paper kindly inserted. Dr. M. Baratta has published an interesting report on "Lo scoppio del dinamitificio di Avigliana e la geofisica (16 gennaio, 1900):" Turin, 1900.

north-east, the explosion was audible around Holsworthy (62 miles from the works), Hartland (68 miles), and Torrington; and to the east at many places in South Devon as far as Exeter, which is not less than 90 miles from the centre of disturbance. Thus the sound must have been heard over nearly the whole of Cornwall, and the greater part of Devon, or over a total land-area of about 3000 square miles.

In the case of the minute-guns fired at Spithead on February 1, 1901, a curious anomaly was observed. In the immediate neighbourhood of Spithead, the sound-waves were almost or quite inaudible, and it was only at a distance of 50 miles or more up to about 80 miles that they attracted general attention. Owing to contrary winds, the sound-waves were refracted over the heads of observers near at hand, and were brought down again by favourable winds to the earth's surface at greater distances. The Hayle explosion affords another instance of this remarkable effect. At Camborne, which is only 4 miles east of the works at Hayle, no one, according to one of my informants, seems to have heard the reports, and, he adds, the wind at the time was blowing in the contrary direction.

The Avigliana Explosion of January 16, 1900.

The little town of Avigliana lies in the valley of the Dora Riparia, a tributary of the Po, about 14 miles west of Turin. As at Hayle, the various buildings which constitute the dynamite factory are isolated from one another, the whole being comprised within an area of about 50 acres.

The first and greatest explosion occurred in the building in which the nitro-glycerine was prepared, and which, at the time, was estimated to contain about 400 kilogrammes of this material. This was followed by the explosion of nearly 12,000 kilogrammes of dynamite and fulminating cotton contained in magazines which were probably ignited by the fall of burning materials from the first building destroyed.

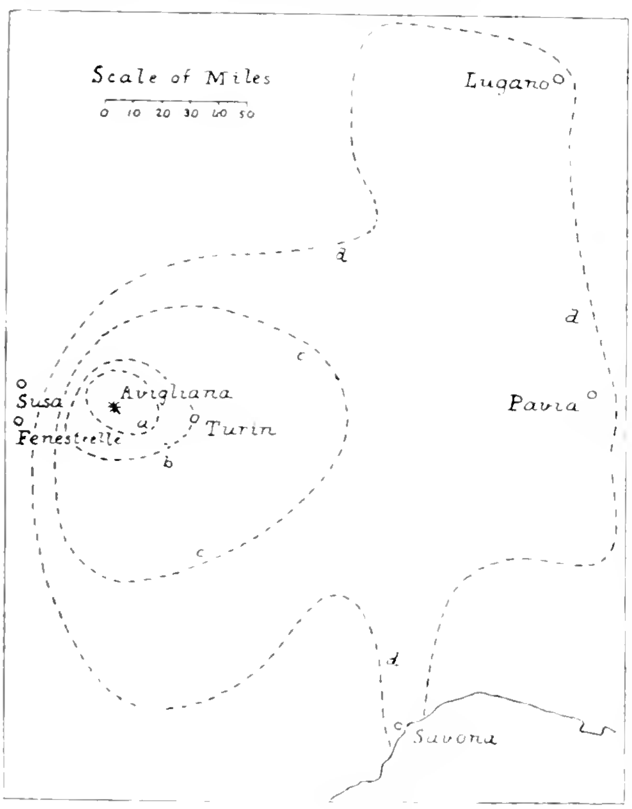


Fig. 2.

The curves in the accompanying sketch-map (fig. 2) give some idea of the distribution of the damage and other effects due to the explosion. The area of maximum destruction was practically co-extensive with the factory itself. At Avigliana, which is about half a mile distant, all the window-panes were broken, and in several of the older houses cracks were made in the walls and arches. Similar, though somewhat slighter, damage occurred at several neighbouring places, all included within the curve marked *a*, which contains an area of about 80 square miles. Outside this central area lies a zone bounded by the curve *b*, containing about 180 square miles and reaching to the western suburb of Turin, within which many, but not nearly all, windows were broken. In the next zone, lying between the curves *b* and *c*, the air wave was strong enough to make doors and windows rattle. It will be noticed that the dynamite factory is at some distance from the centres of all three curves, the last of which (*c*), indeed, extends 30 miles east of Avigliana and only eight miles to the west.

Beyond the latter curve the only effect observed was a rumbling sound like that of distant thunder or a cart of wood being unloaded. This was heard at considerable distances in some directions, but the peculiar form of the curve *d* which bounds it is in part, no doubt, owing to a defective series of observations. Towards the south east it reaches as far as Savona (75 miles), towards the east to Pavia (87 miles), and towards the north east as far as Lugano (99 miles). On the other hand, towards the west the sound was inaudible at Susa and Fenestrelle, both of which are only 17 miles from Avigliana.

Dr. Mario Baratta, who has studied this explosion, considers that the restriction of the curves towards the west is in great part due to the form of the land-surface. Without underrating the effects of the wind, the direction of which at the time of the explosion is unknown, he points out that the path of the waves would be obstructed by the mountain ranges lying to the west and south west, while the open ground along the valleys of the Dora and Po would allow free passage to the sound-waves in other directions. Comparing the curves of fig. 2 with a contour-map of the district, he finds that the report of the explosion was never heard in places situated at an altitude of more than 1000 metres.

NOTES.

ASTRONOMICAL.

A new form of Dipleidoscope.

In a brief note communicated to the Royal Dublin Society, Sir Howard Grubb describes a simple little instrument for readily determining the true time by observation of the sun. The instrument in question, the dipleidoscope, was originally devised more than sixty years ago by E. J. Dent. It consisted of a right-angled prism so placed that the sun, when near the meridian, could be viewed in it obliquely, when two images were seen, the one due to reflection from the first surface, the other to double reflection from the two inner surfaces. The two images would therefore appear to move in different directions, and when the prism was properly set would overlap when the sun was on the meridian. The instrument, however, as originally devised, was open to some serious objections. The one image of the sun was faint, the other excessively brilliant, and neither being magnified, the observation was only a rough one. By covering one-half of the prism with a film of sulphide of lead, and by adding a lens of 20 feet focus, Sir Howard Grubb has been able to make the two images of equal brightness, and sufficiently large for an unskilled observer to determine the time to the nearest second.

* * *

Registration of Star Transits by Photography.

Sir Howard Grubb has made an exceedingly ingenious yet simple suggestion for getting over the difficulty which has been experienced in employing photography to register star

transits. The photographic plate must be made to travel if the registration is to be extended to the fainter stars, and the rate of motion should vary with the declination of the star. The suggested solution would place the object glass of the transit instrument in its horizontal axis, and the photographic plate would travel on the arc of a circle, the centre of which coincided with the centre of the object-glass. This arc would be carried by a polar axis, the prolongation of which would pass through the centre of the object-glass. If the polar axis were driven uniformly by clock work, as in the ordinary equatorial, the plate would always move at the proper rate for the declination of the star to which the telescope was pointed, and would always be in the focus of the transit telescope.

* * *

Burnham's Measure of Double Stars.

Amongst the decennial publications of the University of Chicago is a memoir by Professor S. W. Burnham on his "Measures of Double Stars," made with the 40-inch refractor of the Yerkes Observatory in 1900 and 1901. The memoir is one of very great importance, because the work undertaken by Mr. Burnham was the re-observation of stars which had been neglected, in most cases entirely, for some seventy or eighty years. The majority therefore are wide, or very wide, pairs, and could have been successfully dealt with by the instruments in the possession of not a few amateurs, so that the devotion to them of the largest telescope and the most gifted observer in the world is something to be regretted. But since there was none other fulfilling the duty, Mr. Burnham has performed a great public service in discharging it, and incidentally has succeeded in discovering some eighteen new pairs, some of which are evidently of very high interest.

* * *

Mr. Lowell on Changes in the Martian Canals.

Three papers recently published by Mr. Lowell carry his researches on Mars a distinct stage further. Two of these are issued as Bulletins Nos. 7 and 8 of the Lowell Observatory, and deal with the variation in colour of the Mare Erythæum and the alternating appearances of the canals Thoth and Amenthes. The third paper, entitled "The Cartouches of Mars," was communicated to the American Philosophical Society. In this last Mr. Lowell discusses some 375 drawings of the planet, made during the opposition of 1903 from January 21 till July 26. Eighty-five canals were observed, and each canal on the average might have been seen one hundred times. For each canal a curve or "cartouche" was drawn out to exhibit the percentage of times that it was observed when, from the presentation of the planet, it should have been visible, for different intervals after the summer solstice. The mean cartouches for the different zones are far from being convincing, and represent the smoothing out of many discordances. It may be granted, however, that there is some slight resulting evidence that on the whole the date of greatest distinctness for a canal falls later in the summer of Mars in proportion to its distance from the pole. This darkening of the canals proceeds towards the equator at a speed of 53 miles a day. Mr. Lowell considers this as motion in the face of gravity, the equatorial radius of Mars being eleven miles greater than the polar, and as demonstrating that the canals are waterways and that the water is raised to this height by artificial means. The Thoth and the Amenthes offer a case, according to Mr. Lowell, of alternative canals, the one canal being visible in one season and the other in another. Mr. Lowell also finds that the Mare Erythæum shows a distinct blue-green tint at the time when he infers there is most moisture in the region and a chocolate-brown when there is least, a change he ascribes to the decay of vegetation.

* * *

Sunspots and Terrestrial Magnetism.

Professor Riccò contributes an important memoir on this subject to the Società degli Spettroscopi Italiani. He refers at length to Mr. Maunder's recent paper on the nineteen great magnetic storms of the last thirty years, and fully adopts his conclusion that there is a real connection between sun-spots and such storms. Mr. Maunder found that the storms began on the average 26 hours after the transit of a great spot across the central meridian of the sun. Professor Riccò finds that the maximum violence falls about $45\frac{1}{2}$ hours after the transit. As the mean duration of a storm is 33 hours, the two determinations are almost precisely in accord. Referring to a number of suggestions which have been made to explain the sun's influence on terrestrial magnetism, Professor Riccò appears to favour that of Arrhenius, who suggests ions, driven from the solar surface by reason of the pressure of radiation: their velocity being nearly that indicated by the interval mentioned above.

ZOOLOGICAL.

Early Opening of the Right Eye.

In a note to certain observations on the gestation of the badger, published in the March number of the *Zoologist*, Mr. A. Heneage Cocks records the following very remarkable circumstance: "I have never seen the fact noticed," he writes, "that the right eye of young mammals opens before the left. I do not remember an exception among wild animals, nor even among domestic animals, though it is very likely some occur in the latter class. From the time the lids of the right eye begin to part to the time the left eye is fully opened takes generally from 36 to 40 hours." The fact is as new to us as it is to Mr. Cocks, and requires an explanation. The suggestion naturally occurs that the phenomenon is connected with "right-handedness" in the human species; but before such an explanation can be accepted, we want to know whether carnivorous and rodent mammals, and the members of such other groups as have the young blind at birth, display a similar preference for using the right limb. The horse, it is well known, displays a decided tendency to "lead with the left foot;" but in this species, in common with other ungulates, the young are born with their eyes wide open. And what holds good in this respect with domesticated horses may not obtain among carnivores and rodents.

* * *

The "Pearl Organs" of Fishes.

The males of certain species of North American fishes develop during the breeding season what are known as "pearl-organs." These are hard spine-like thickenings of the epidermis, sometimes forming rows on the sides of the tail and on the anal fin. Their use long remained unknown. Mr. J. Reighard, of Michigan University, finds, however, that they are employed by the males of some species for fighting and in building their nests, while in all the species they are used for holding the spawning female.

* * *

Whale Collisions.

Two instances of the sudden destruction of whales by collision have recently been recorded in the daily papers. In the one instance the look-out on a liner noticed a large whale disporting himself on the surface of the water immediately ahead, but, thinking that the monster would get out of the way in time, the vessel was allowed to pursue her course. Instead, however, of moving, the whale remained where he was, and was caught "amidships" by the bows of the steamer, which cut him completely in two. For two or three miles, it is said, the vessel ploughed her way through water crimsoned with the leviathan's blood. The second case is recorded in a telegram sent from Vladivostok on March 30. "A violent explosion," runs the message, "recently occurred at sea in Possiet Bay, the cause of which could not be ascertained. Two days later the body of an enormous whale was washed into the bay by the tide, the creature having evidently collided with and exploded a mine."

* * *

Monkeys and Altitude.

A recent issue of the *Atti* of the Royal Academy of Rome contains an account of the effects produced on baboons and monkeys by conveying them to a high elevation on Monte Rosa. The ill effects seem more pronounced than in the case

of human beings. The action of the low barometric pressure appears very similar to that of narcotics, producing at first unusual activity and excitement, followed by sleepiness, insensibility, and, finally, death.

The Brain of Man and Apes.

For many years Professor G. Elliot Smith, of the Egyptian Government School of Medicine, has been devoting his attention to the study of the brain in man and other mammals. Recently, in the *Anatomischer Anzeiger* (Jena), he has published a preliminary account of what appears to be an exceedingly important discovery. The human brain, as known by European specimens, has been supposed to differ from that of apes and monkeys by the absence of the so-called simian fold ("Affenspalte") on the posterior portion of the main hemispheres. On studying a large series of Egyptian and Sudani brains, Professor Smith finds, however, that this simian fold, or sulcus, can be distinctly recognised.

"It is easy," he writes, "to select examples from the series of Egyptian and Sudanese brains in my possession in which the pattern formed by the occipital sulci on the lateral surface of the hemisphere in individual anthropoid apes is so exactly reproduced that the identity of every sulcus is placed beyond reasonable doubt. . . . And if we take individual examples of gorilla brains it becomes still easier to match the occipital pattern of each of them to numerous human brains. . . . It is easy to appreciate the difficulties which have beset investigators of European types of brain, and to understand the reasons for the common belief in the absence of the supposed distinctly simian sulci in the lateral aspect of the occipital region of the human brain."

Thus disappears one more of the supposed structural distinctions between man and his nearest relatives.

Zebra Taming at the Zoo.

All interested in the progress of the Zoological Society's Menagerie in the Regent's Park, and the attempts now being made to render it more attractive to the general public, will have heard with unfeigned regret of the sudden death of the Grevy zebra stallion shortly after the first trial at breaking it for the saddle. With regard to the experiments made for taming all the specimens of the zebra at present in the collection, it appears that the smallest and quietest of the three mares was some time ago broken in with very little trouble. On March 15, "Jess," a larger and somewhat less docile mare, was taken in hand, with most successful results; and the same afternoon the third mare was handled with equal success. All three mares have since been going about quietly in harness, although it was deemed advisable not to take "Jess," as being by far the most powerful, beyond the limits of her paddock. On the following day, March 16, the Grévy stallion was taken in hand, although it was never intended that he should be employed for riding purposes. Although some temper was displayed by the stallion, he was eventually broken with complete success. During the next two days he seemed perfectly well, but he showed signs of being out of condition on Saturday, and, after refusing to get up on the morning of the Sunday, he died that night.

The post-mortem examination was made on Wednesday, March 23, by Dr. Salaman, Director of the Pathological Institute at the London Hospital. The immediate cause of death was heart-failure, but Dr. Salaman was unable to find evidence of the actual cause of failure: the complete absence of signs of injury or disease being similar to the case of a Grant's zebra examined by him at the beginning of March, which had died in the Gardens without having undergone any training or breaking-in.

Although it is obviously impossible to be certain that the death of the Grévy was unconnected with the breaking-in, it is satisfactory to know that there was no sign of injury to any of the internal organs. The bones were, however, unusually brittle, and the stallion was much older than had been supposed. Our readers will be glad to hear that this untoward event is not to be allowed to interfere with the progress of zebra-training.

The Collections of the "Discovery."

According to the daily papers, the results of the expedition of the "Discovery" to the Antarctic do not appear to have added anything very striking to our biological knowledge. So far as zoology is concerned, the most important item is, perhaps, the discovery of a "primitive type" of insect. Valuable information with regard to the bird life is, however, said to have been obtained. Most important of all appears to be the discovery of a number of fossil plant remains, which are said to confirm the theory of a former land connection, by way of "Antarctica," of the southern continents and islands.

BOTANICAL.

An Abnormal Fern.

Aspidium anomalum is a fern found growing at high elevations in Ceylon. It closely resembles the British *A. aculeatum*, of which it may be merely a form, and very remarkable on account of the sori being developed on the upper instead of the under side of the fronds, the usual position for them. The plant is now in cultivation in this country, its large handsome fronds rendering it of considerable horticultural merit. The species was first described by Sir William Hooker nearly half a century ago under the name of *Polypodium anomalum*, and he regarded it as an abnormal form of *P. vestitum*. He found that the indusium was entirely absent even in the youngest stages of the fructification, while in *P. vestitum* it was very early deciduous. Other ferns are known to occasionally develop a few sori on the upper side of the frond, as in *Deparia Moorei*, where they are confined chiefly to the margin, and sometimes in *Asplenium Trichomanes*. Sir William Hooker refers to a specimen of this species, collected in Italy, in which, in addition to the numerous sori on the under side of the frond, there was one pinna "bearing a solitary sorus on the disc of the upper side." In the specimen from which *Aspidium anomalum* was first described a few sori were found on the under side of two or three pinnules of a frond.

A Primitive Food.

Professor F. V. Coville has just published an interesting paper on a primitive food of the Klamath Indians, produced by a congener of our yellow water-lily (*Nuphar luteum*), and known under the native name of Wokas. This plant is *N. polysepalum*, called by American botanists *Nymphaea polysepala*, and is found in great abundance in the reservation occupied by the Klamath Indians in the south-western corner of the plateau of eastern Oregon, at the eastern foot of the Cascade Mountains. A huge marsh in this reservation, known as the Klamath Marsh, contains no less than ten thousand acres of the Wokas, which flourish to the exclusion of almost every other kind of vegetation. The seeds are subjected to various tedious processes by the natives and ultimately furnish a wholesome farinaceous food, which is regarded as a great delicacy, and which Professor Coville thinks might be successfully brought into commerce as a breakfast food, though he does not consider the cultivation of the plant for commercial purposes to be feasible, and the supply of the seeds would be dependent on the wild crops. The order Nymphaeaceae is not important economically. The seeds of the *Victoria regia* are eaten by the natives of Guiana and Brazil, and the stem of the Sacred Lotus (*Nelumbium speciosum*) "is used as food in India and China, though probably only in times of scarcity."

PHYSICAL.

On a Novel Radiation Phenomenon.

Mr. J. J. Taudin Chabot* some time ago ascertained whether selenium in its conductive modification, being sensitive to light, may give rise to radio-active phenomena. To this effect he used a selenium cell of the Shelford Bidwell type, the

* *Physikal Zeitschr.*, No. 4, pp. 103-104, 1904.

effective mass of which was uniformly distributed on the surface of a platinum wire. After having been in the dark for many weeks, the platinum selenium surface was covered, at a red illumination, with a sheet of silver bromide jelly to which a sensibiliser absorbing the yellow and green rays was added, an aluminium strip bent at right angles being interposed. After the whole system had been kept in the dark for another 48 hours, the same experiment was repeated, using a fresh silver bromide jelly sheet, while a current of about 110 microamperes traversed the selenium. Now the following results were observed on the developed jelly sheet:—

In the first case, some bright spots corresponding apparently to the outline of the aluminium angle were noted on a dark background, whereas, in the second case, a dark silhouette of the whole of the angle without any details resulted on a bright background, some brighter narrow transversal bands being visible at the same time. These bands were produced more efficiently in the case of repeated expositions, thus allowing of ascertaining that they are due either to the parallel platinum wires or to the selenium interposed between each two of these, or finally to the points of contact between the platinum and selenium, where the Peltier effect must give rise to an evolution of heat either positive or negative, on the passage of the current.

On continuing these experiments, Mr. Chabot noted the fact that the back of the plate bearing the platinum selenium wire was equally capable of affecting the silver bromide jelly, dark silhouettes on bright background being then obtained. As to the question whether these results are an evidence of the existence of some novel radiation, or else an emanation from the surface of conductors, the author hopes to publish in due course some further investigations allowing of more definite conclusions being drawn.

Radium and Heat.

In the course of an experimental investigation of the influence of radium on the rate of cooling of a body placed in a gaseous medium, Mr. Georgiewsky, in a paper recently read before the Russian Physico-Chemical Society, arrives at the following conclusion:—

1. The rate of cooling of heated bodies in the various gases is not modified under the influence of radium.

2. The rate of cooling of non-electric heated bodies placed in one of the gases examined (hydrogen, lighting gas, air and carbonic acid) on being exposed to the action of radium is augmented in the case of the heated bodies being electrified. The rate of cooling in this case will augment not only under the simultaneous influence of the α, β and γ rays of radium, but as well under the exclusive action of β and γ rays.

3. The increase in the rate of cooling of a heated body is greater as the body is negatively charged.

4. The relations existing between the increase in the thermic conductivity and the potential of a charged and heated body may be represented by means of curves analogous to those by which Mr. Townsend expresses the connection between $\alpha : p$ and $X : p$ for the same gases (*Phil. Mag.* 6 ser. V. 5, p. 571).

A. G.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Breeding Habits of the Common Buzzard (*Butea vulgaris*).

PROFESSOR J. H. SALTER gives an exceedingly interesting account of his observations on the nesting habits of the Common Buzzard in the "Zoologist" for March. Of the three young which are almost invariably hatched, he remarks that, in the hill districts, the oldest bird will commonly kill one or both of the younger nestlings; apparently for the purpose of securing their share of the food brought by the parents. In support of this view he points out that this unnatural behaviour is not noticeable when the young are reared in the more fertile valleys where food is plentiful.

He also describes a curious habit which the parents have of decking the lining of the nest with freshly-plucked leaves and twigs, especially of birch, and rowan, and bracken.

Birds breeding in Wales furnished the material for this extremely interesting history.

* * *

Greenland Falcon in Donegal.

It has just come to light that an immature bird of this species was trapped in Donegal in December last. This makes the thirty-second record of this species for Ireland, and the tenth for Donegal.

Nutcracker in Northamptonshire.

A trap set for "vermin" in February last, at Tywell, captured instead a Nutcracker, whilst one is reported to have been seen in Devonshire during the same month.

The Emperor Penguin.

A statement has been going the round of the daily papers to the effect that one of the results of the newly-returned *Discovery* Expedition to the Antarctic has been the capture of the Emperor Penguin, a bird which had "not previously been found in these regions." Of course this is a mistake; but we are glad to learn that the eggs of this bird have been taken, for they have not hitherto been, and will therefore form a welcome addition to the collections of the National Museum at South Kensington.

All communications intended for this column should be addressed to:—

W. P. PYCRAFT,
Natural History Museum,
South Kensington.

REVIEWS OF BOOKS.

FIRST CAUSES.

The Old Riddle and the Newest Answer. By John Gerard S.J., F.L.S. (Longmans.) The old riddle which the Rev John Gerard tries, not to answer, but to state, is that which asks whether it is possible to explain the universe without admitting the existence of a Creator. The answer he gives is that no theory which has yet been formed can relieve us from the necessity of imagining a First Cause: there must have been a God, a Divine Intelligence greater than any intelligence which man can attain. Mr. Gerard's conclusion is well stated in a quotation from the late Professor Baden-Powell—"That which requires thought and reason to understand must be itself thought and reason. That which mind alone can investigate or express must be itself mind. And if the highest conception attained be but partial, then the mind and reason studied is greater than the mind and reason of the student. If the more it be studied the more vast and complex is the necessary connection in reason disclosed, then the more evident is the vast extent and compass of the intelligence thus partially manifested . . . ." But though we have no quarrel with the conclusion that Mr. Gerard reaches, and though we may admit that it has been expressed in varying forms by the greatest of scientific men—by Kelvin, by Lamarck, by Sylvester, even by Huxley—there is a distinct objection to the means he has taken to reach it. He opposes the theory of Evolution by the doctrine of Design. A very large part of his volume is occupied by an attack on Darwinism, which we cannot even admit to be a fair attack. Darwin's theory is not infallible: its too zealous advocates have sometimes stretched it farther that it can legitimately be held to go. In any case it is but a working model, and, like the atomic theory, or the theory of the ether, or the chemical theory of ionic dissociation, or the new theories based on radio-activity, it is to be regarded not as a complete explanation, but as a hypothesis which enables us to account for many of the facts. Even if it were completely true, it would not prejudice the belief in a Creator; if it were proved entirely mistaken it would not strengthen that belief. Why

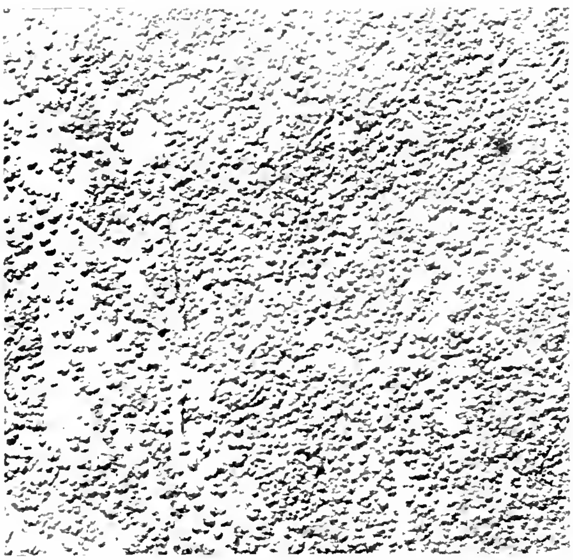
then assail it as a factor in the argument. If, on the other hand, the Darwinian theory be assailed on other than dialectic or theological grounds, then the first necessity is to be scrupulously fair, meticulously exact. We have not space to consider critically all the quotations which Mr. Gerard brings forward as evidence against it: but we may briefly refer to one part of his case, which is contained in the chapters on the geological record. He quotes with approval the attacks which Mr. Carruthers made in 1870 as President of the Geologists' Association, and later in book form (1898), on the incompleteness of the botanical fossil record, and its failure to show any connecting link between the greater divisions of plants. But Mr. Gerard entirely ignores the work which has been done since 1898 by Professor A. C. Seward, Dr. D. H. Scott, and Professor F. W. Oliver in fossil botany, and the opinions expressed by them. To quote but a single instance: Dr. D. H. Scott and Professor F. W. Oliver have within the last twelve months shown reason for connecting the Ferns with the Cycads; and have exhibited in Lyginodendron a seed bearing fern. Not, however, to go into too great detail, we may quote from Professor Seward's British Association address an observation made by Darwin himself on the imperfection of the geologic record. "The crust of the earth, with its embedded remains, must not be looked at as a well-filled museum, but as a poor collection made at hazard and at rare intervals." And the transitions of form and species are not incompatible with evolutionary theory.

A Chemical Conception of the Ether. By Professor D. Mendeléeff. (London: Longmans, Green, and Co.) The discovery of the radio-active properties of some of the metals, and the probability which Lord Kelvin remarked, that most substances are radio-active to a greater or less extent, has been one of the corroborative facts to sustain the electro-atomic theory of matter. That theory has been hesitatingly received by many chemists, who have not hesitated to dispute the objective reality of atoms, regarding them merely as vehicles for expressing relations between the elements, and who have seen in the extension of the theory so as to take in "atoms of electricity" or "electrons," or "twists in the ether," an unprovable hypothesis which they do not need to explain chemical inter-action. The attack on the physicists' conception of the atom of matter as an imperceptibly small system of forces in which electrons revolve at enormous speeds and possibly in concentric rings (not unlike a solar system in miniature, or the rings of moons about the planet Saturn) has not hitherto been very well directed. It has in at least one instance put forward an untenable explanation of some of the facts of radiation; and while ignoring the fact that the "electron" theory does explain the radiation of radium and thorium very well, has offered no alternative theory. Professor Mendeléeff's theory of the ether removes, however, the latter reproach, and offers a supposition which, though awaiting the test of mathematical examination on the part of the physicists, is an extremely interesting one. He boldly sweeps away the anomalies of believing the ether to be an all-pervading substance—rigid as steel, yet interpenetrating all matter; frictionless, but without weight—by imagining it to be a gas that has weight and substance, though it is of such extreme tenuity that it is capable of interpenetrating all other substances and incapable of offering a measurable resistance to their passage among its molecules. Its insusceptibility to chemical combination is to be regarded as similar to a similar inertia on the part of helium or argon, or the gas emanating from radium; its imponderability is not real, but due merely from the absence of any known means of weighing it. Professor Mendeléeff calculates that this theory would fulfil the requirements mathematically demanded from it if the ether, the lightest element, and its particles and atoms had an atomic weight nearly one-millionth that of hydrogen, and travelled with a velocity of about 2250 kilometres a second. We need not follow Professor Mendeléeff's theory in all its details, but it will not be uninteresting to summarise the way in which it responds to the demands put on it to explain radio-activity. Although the ether, or, as he calls it, the lightest of gases, x, has no power to form stable chemical compounds, it would not be deprived of the faculty of dissolving in, or accumulating about, large centres of attraction—like the sun among heavenly bodies, or the heavy uranium and thorium atoms. If the ether be a gas x it must naturally accumulate from all parts of the universe towards the heavy suns, just as the gases in the atmosphere accumulate in a drop of water. Similarly it will accumulate towards the heaviest atoms of thorium or uranium. *If such a special accumulation of ether atoms about the molecules of radium and thorium be admissible, they might be expected to exhibit peculiar phenomena determined by the emission of a portion of this ether held by particles of normal mean velocity and by new ether entering into the sphere of attraction.* In short, the theory of the great Russian chemist is not unlike in form that explanation suggested by Sir William Crookes and Dr. Johnstone Stoney, and partly confirmed by Lord Kelvin, that the radiation of radium, thorium, &c., is sustained by energy from without rather than from within.

The Essential Kaffir. It is to the human interest of the Kaffir that Mr. Dudley Kidd devotes himself in his valuable and entertaining book, "The Essential Kaffir." (Adam and Charles Black.) He uses the word Kaffir in its broadest sense to include all the dark-skinned tribes of South Africa; his information concerning the people of whom he writes is intimate and varied, comprising the gleanings of a dozen years, repeated visits to their tribes, visits in which he associated with them in terms of intimacy, slept in their huts, watched their habits of life and their social and religious customs, memorialising them in many admirable and curious photographs which add greatly to the value and interest of his book. There is, for instance, the photograph of the mother feeding her baby with sour milk out of her hand, while a lean dog watches the operation with sympathetic interest. In the next photograph the dog is being utilised as a napkin to lick the baby's face clean, while the mother holds its unwilling countenance steady with one hand while she guides the dog's head with the other. Mr. Kidd describes a night spent in a Kaffir hut in company with the Kaffir family and such household pets as a calf, a dog, roosting fowls, and others who shall be nameless, but who could scale even sandbanks of Keating. One feels as one reads that self-sacrifice in the cause of knowledge could go no further. Very interesting are the chapters on Kaffir mental characteristics, on their musical instruments and games, and on their religious beliefs. Of their mental powers he notes the curious fact that the native children sometimes absorb knowledge with a singular precocity, but as they develop their brains, as it were, seem to stop growing, their energies appear to be absorbed in their bodily development, and whether caused by "mechanical formation of the bones of the skull or not, must be left to men of science to settle; yet the fact of stunted mental development remains." At the same time the natives are remarkable for their extraordinary memory of facts which interest them, such as the precedents in a legal case. In a book where every page is interesting, an adequate idea of its contents can hardly be given in so short a space. All such people as the Kaffirs here described must rapidly lose much of their individual character in contact with other civilisations, and a book that crystallises their essential characteristics from intimate observations has a more than ephemeral interest.

Physical Chemistry in the Sciences, by Jacobus Van't Hoff. (Chicago: The University Press.) To the Decennial publications of the University of Chicago have been added the series of lectures which were delivered there by the German chemist, Van't Hoff, and which deal with "Physical Chemistry in the Service of the Sciences." The lectures, lucid, terse, concentrated, deal with Physical Chemistry in Pure Chemistry, in Physiology, in Geology, and in Industrial Chemistry. From the last-named chapter we may make an extract which should be very serviceable in bringing home to the British nation the true reason for the growing strength of the German competitor in industries that for many years were chiefly British. "There exists in Germany," says Van't Hoff, "a very beneficial co-operation between laboratory work and technical work. Both go as far as possible hand in hand. After physical chemistry had made several important advances, and was firmly established in such a way that pure chemistry was assisted by co-operation with it, Professor Ostwald judged correctly that this co-operation would be valuable in technical directions. In this belief he founded the Electro-Chemical Society. . . . All the most conspicuous chemical industries of Germany are represented in the Society, which has its own organ of publication. Nor has the stimulus to this co-operation come purely on the

scientific side. That it comes from both parties may be seen. for example, in the fact that a year ago Professor Goldschmidt, of the University of Heidelberg, was asked by the Director of the 'Badische Anilin-und-Soda Fabriken' to give a series of lectures on this branch of science before the chemists of the factory, and did so with great success. An opening up of new points of view, rather than immediate practical results, was expected to flow from these lectures." all of which should



A plate of tin affected by Tin Disease (enlarged one and a half times).
(From "Physical Chemistry in the Sciences").

strengthen a case, already overwhelming, for the establishment of English Charlottenburgs. From Van't Hoff's lecture on Industrial Chemistry, we take also a plate illustrating a curious so-called disease of tin. It is rather a transition of tin from one form to another, and has been recognised as of actual occurrence since the time of Aristotle. Van't Hoff described the beautiful methods, largely due to the investigations of Schaum and Cohen, by which the conditions which influence this extraordinary change have been determined.

BOOK NOTICES.

Geometry. In addition to "A School Geometry (Parts I.–IV.; IV., V.)," by H. S. Hall, M.A., and F. S. Stevens, M.A. (Macmillan), which we received last month, and which provides a course of elementary geometry based on the recommendations of the Mathematical Association and on the schedule recently proposed and adopted at Cambridge, we have received also "Elementary Geometry" (Parts I. and II.), by Cecil Hawkins, M.A. (Blackie), which departs even more boldly than other works based on the tenets of mathematical reform, and which, with practical illustrations, takes pupils and classes, not through the routine of Euclidian propositions, but acquaints them by progressive stages with the ascertainable properties of "Intersecting Straight Lines," "The Triangle," "The Circle," "Polygons," and so on to areas and to numerical theorems treated numerically.

Domestic Economy Reading Books, Vol. II., "The Marshfield Maidens and the Fairy Ordina," by Mrs. W. H. Wigley (Thomas Murby, 3, Ludgate Circus Buildings, E.C.).—Simple lessons in household duties are conveyed in narrative form.

Logarithims for Beginnings, by Charles Pickworth (Whittaker and Co., 2, White Hart Street, E.C.).—A simple introduction to the study of the subject, intended to give a more detailed and practical explanation of logarithms and their various applications than is to be found in text-books on algebra and trigonometry.

Worked Problems in Higher Arithmetic, by W. P. Workman and R. H. Chope (W. B. Clive, University Tutorial Press).—A collection of problems in higher arithmetic, intended especially for students who are preparing for Civil Service Examinations. It will also be of service to teachers.

Tables of Multiplication, Division, and Proportion, by Robert H. Smith, M.I.M.E. (Archibald Constable).—These elaborate tables will be useful in the ready calculation of quantities and costs, estimates, interests, wages and wage premiums, &c.

The Story of Creation, by Edward Clodd (Watts and Co Sixpenny Edition, with numerous illustrations and good type). —It gives an account of the theory of evolution in clear and popular form, dealing with the distribution of matter in space, the past life history of the earth, present life forms, the origin of life and of species, and social evolution.

An Agnostic's Apology, and other Essays, by Sir Leslie Stephen, K.C.B. (Watts and Co. Sixpenny Edition.)—Contains Essay on "Materialism," Newman's "Theory of Belief," "Toleration."

Remarkable Comets, by William Thynne Lynn, B.A., F.R.A.S. (Sampson Low, Marston, and Co. New Edition).—It reviews briefly the most interesting—perhaps we should say the most popular—facts in the history of Cometary Astronomy.

A Safe Course of Experimental Chemistry, by W. T. Boone, B.A., B.Sc. (W. B. Clive, University Tutorial Press).—A short course of chemical experiments, designed to train students in solving elementary problems by experiment, in accuracy in their work, and in reasoning from observation. It is especially intended for the London matriculant who intends to take the Intermediate Science Examination, or for students in training colleges who have to take the prescribed course in general elementary science.

Second Stage Botany, by J. M. Lowson, M.A., B.Sc., F.L.S. (W. B. Clive, University Tutorial Press).—This is an adaptation of the "Text Book of Botany" to the requirements of the second stage examination of the Board of Education, South Kensington. The first part of the book deals with morphology, histology, physiology; the diagrams and illustrations are numerous and clear, and will be very helpful to students.

Modern Navigation, by William Hall, B.A. (W. B. Clive, University Tutorial Press), is intended primarily as a text-book for students of navigation and also as a handbook for navigators. It will be found useful in the various examinations of the Royal Navy, the Mercantile Marine, and the Board of Education. The explanation of compass deviations and tides will introduce the student to more detailed works on the subject.

Pocket Edition of the Works of John Ruskin (George Allen). —A small and pretty edition of Ruskin reprints, light to hold, and pleasant to read. "Sesame and Lilies," which deals with "The Mystery of Life and its Arts," and insists that "those of us who mean to fulfil our duty ought first to live on as little as we can; and secondly to do all the wholesome work for it we can, and to spend all we can spare in doing all the good we can."

The Crown of Wild Olive; Essays on "Work and War and the Future of England," and "Lectures on Art"—Essays on the Relation of Art to Morals and the Relation of Art to Use. These three volumes contain some of the most strenuous common-sense and right-thinking in Ruskin's works.

Messrs. John Wheldon and Co., of Great Queen Street, have issued a clearance catalogue of a miscellaneous collection of books. The volumes include works on botany, entomology, and ornithology. There are especially to be noted some works on fungi and publications relating to meteorology.

Messrs. Isenthal's new catalogue is well worth attention for the completeness of the Rontgen-ray and allied apparatus which their manufacturers offer. The very large and greatly increasing numbers of devices used in electro therapeutics and in the new methods of the light treatment of disease are specially noticeable.

Messrs. Harry W. Cox's new catalogue of X-ray and high-frequency apparatus includes an extension of their previously issued practical hints to beginners. These hints, covering work with X-ray coils, mercury and other interrupters, and describing the best methods of connecting rheostats and charging accumulators from the mains, are extremely useful, and much to the point. They add distinctly to the value and interest of the catalogue.

BOOKS RECEIVED.

A Systematic Survey of the Organic Colouring Matters, by A. G. Green, F.I.C., F.C.S. (Macmillan.) 21s. net.

My Airships, by A. Santos Dumont. (Grant Richards.) Illustrated; 6s. net.

Five Years' Adventures in the Far Interior of South Africa, by R. Gordon-Cumming. (John Murray.) Illustrated; 2s. 6d. net.

Radium and all About It, by S. Bottone. (Whittaker & Co.) Illustrated; 1s. net.

A Text Book of Geology, by W. Jerome Harrison, F.G.S. (Blackie & Son.) Illustrated; 3s. 6d.

Dyes, Stains, Inks, Varnishes, Polishes, &c., by Thomas Bolas, F.C.S., F.I.C. (Dawbarn & Ward.) Illustrated; 6d. net.

Metal-Working, by J. C. Pearson. (Murray.) Illustrated, 2s.

Practical Slide Making, by G. T. Harris, F.R.P.S. (Iliffe.) Illustrated; 1s. net.

Phylogeny of Fusus and its Allies, by Amadeus W. Grabau. (Smithsonian Institution.)

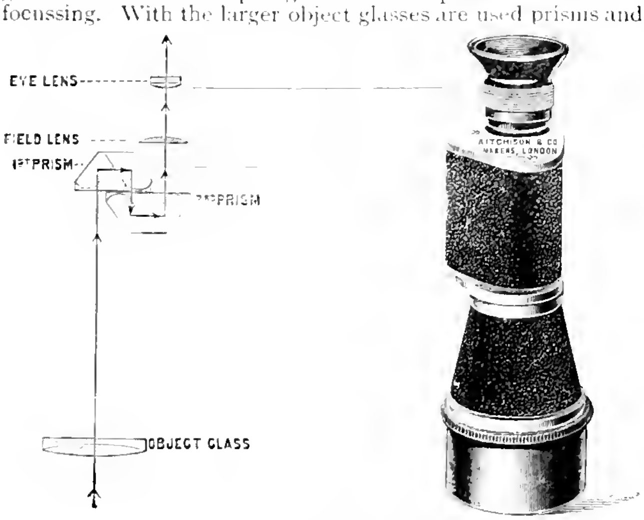
Researches on the Attainment of Very Low Temperatures, by Morris W. Travers, D.Sc. (Smithsonian Institution.)

Nature's Story of the Year, by C. A. Witchell. (Fisher Unwin.) Illustrated; 5s.

Notes on the Composition of Scientific Papers, by T. C. Allbutt, M.A., M.D., &c. (Macmillan.) 3s. net.

The Aitchison Prism Field Glasses.

The Aitchison Prism Field Glasses, specimens of which have been sent to us for review, represent a considerable adaptability alike of mind and of method on the part of British opticians. The effectiveness and popularity of the Continental prism glasses were such as to leave no doubt in the mind of opticians that in imitation lay the only form of successful competition, and that to imitation must be added improvement. In consequence a great deal of money has been spent with this end in view; and the Aitchison glasses represent a very gratifying measure of achievement as a return on the outlay of expense and ingenuity. The principal features of the glasses that we have before us are the use of large object glasses, variable diaphragms, and improved means of focussing. With the larger object glasses are used prisms and



The Black Line with arrow head shows the path of rays of light in the New Aitchison Prism Field Glass.

lenses of a higher index of refraction than ordinarily employed. The prisms are very much larger than in the German glasses. The introduction of variable diaphragms is a quite new departure in the construction of field glasses. A pair of Iris diaphragms are in this case introduced into the tubes close to the object glasses and ground together so that they are worked simultaneously from the toothed wheel on the central pillar. By this means, as in the photographic camera, all unnecessary rays can be cut off when the light is brilliant, and in dull weather and at night the whole available aperture of the object glasses can be used, thereby effecting an immense advantage over the old form with fixed diaphragms. Another benefit is the rigidity of the body, which is secured by casting the two tubes and crossbars in one piece instead of building them up in separate parts as hitherto.

University College Lectures.

The following Courses of Lectures will be delivered during May at the University College, London.

Course of 10 Lectures on the HISTORY OF MODERN PHILOSOPHY, by Mr. A. Wolf, M.A. First Lecture, April 26th, 4 p.m.

Course of Lectures on COMPARATIVE LAW, by Prof. Sir John Macdonell, M.A., LL.D., C.B. Commencing April 26th.

Course of 10 Lectures on the HISTORY OF ARCHITECTURAL DEVELOPMENT, by Prof. F. M. Simpson. Commencing April 22nd, 11 a.m.

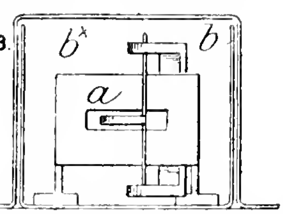
Introductory Course of 12 Lectures on IDEALISTIC ETHICS, by Prof. G. Dawes Hicks, M.A., Ph.D. Tuesdays and Thursdays, 5 p.m. Commencing April 26th.

Course of Eight Lectures on POST-ARISTOTELIAN PHILOSOPHY, by Prof. G. Dawes Hicks, M.A., Ph.D. Tuesdays, 4 p.m. Commencing May 3rd.

Recent Patents.

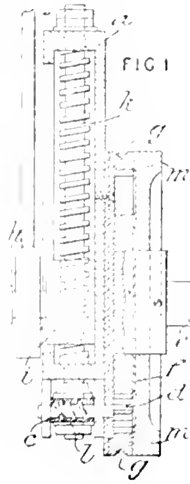
19,652. Electricity, measuring. Nalder, F. H., and Nalder Bros. and Thompson, 34, Queen Street, London Sept. 8.

FIG. 3.



Current Meters.—An ammeter or volt-meter, having a soft-iron needle movable about an axis at right-angles to the magnetic axis of a coil *a*, is provided with a magnetic shield *b*, *b*ˣ of soft iron or mild steel, which may be enclosed in an ordinary cast iron casing. The shield has the form of a cubical box surrounding the coil, its ends being open. It may be in two parts, as shown, one overlapping the other tightly. Or it may be in one piece, the ends of which are overlapped.

23,731. Variable-speed mechanism. Mitschke Smith, W., and Mitschke-Smith, G. F., both of 7, Rue Drouot, Paris. Oct. 30.



Relates to variable-speed mechanism, particularly for use with motor cars and in connection with friction-ratchet driving-apparatus, such as is described in Specification No. 20,135, A.D. 1902. A crank *a* mounted on a shaft *c* has the crank pin *h* mounted on a nut *i*, which can move on a screw *k* in the crank *a* for producing a variable throw. The screw *k* terminates in a worm wheel *l*, which gears with the worm *c* on a short shaft carrying a pinion *d*. The pinion *d* engages with both a loose toothed wheel *f*, and a loose inner toothed ring *g*. The wheel *f* is fixed to the disc *m* so that either *f* or *g* can be retarded by a brake. When either is retarded, the pinion *d* is caused to rotate, and, through it, the screw *k* and the nut *i* relatively to the crank *a*.

23,733. Photography. BECK, C., 68, Cornhill, London Oct. 30.

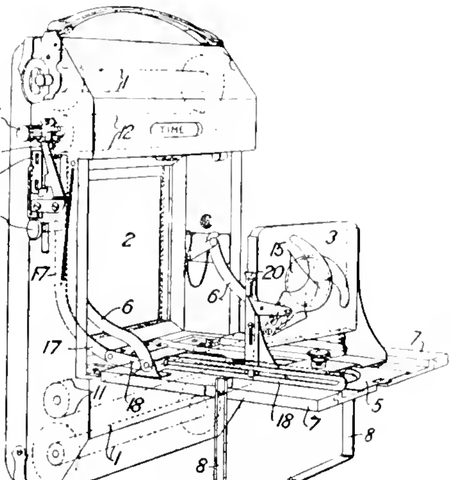
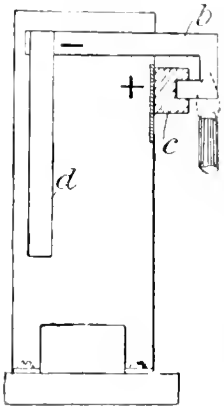


FIG. 1

Cameras; roller slides; shutters.—Relates to a camera with roller slide and two shutters, one at the focal plane and one at the lense. The camera is shown in Fig. 1, with the bellows removed. The rollers 12, 11 of the blind shutter are mounted between rollers 1 of the roller slide. The front 3 is mounted on metal runners 5 fixed in the middle of the hinged base-board 7. To fold up the camera, the front 3 is pushed back, the stays 6 are disconnected, and the base-board 7 is folded up on the back. The camera is supported by a metal frame 8, which is pivoted to a base-board 7 so that it can be turned over the end of the latter in folding up the camera. The focussing is done by moving an arrow on the front along a scale of distances on the base-board, lines being marked on each side of the arrow to indicate depths of focus for the different lense apertures. The lense shutter, which consists of two hinged plates 15, is closed while the roller blind shutter is being set by turning the button 25. To make an exposure, the button 16 is depressed, a movement which, acting through the links 17, 18, 20, or through a flexible shaft, opens the shutter 15, then lifts the pawl 14, which releases the roller blind shutter, and makes an exposure. The blind shutter has two apertures, one equal in size to the aperture 2 in the back of the camera, and a narrower aperture for more rapid exposures. There is an adjustable stop arrangement in the blind roller 12 by means of which either of these apertures can be used. This stop arrangement consists of an axial screw actuated by the roller 12 and thus moved lengthwise, till it comes against a stop and arrests the shutter. For a time exposure, the large aperture of the roller blind is brought opposite the opening 2 and held there by the pawl 14, which is locked by a sliding plate 81. The time exposure is then made by the front lense. A method of holding the spools of roller slides so that they can be easily removed or inserted is described. A spring is placed at one end of the spool so that it can be pushed back to liberate the other end.

23,858. Thermo-electric batteries. JOHNSON, J. Y., 47, Lincoln's Inn Fields, London.—(*Wolf & Co., A., Bleichstrasse, Frankfort-on-the-Main, Germany*) Oct. 31.

FIG. 1

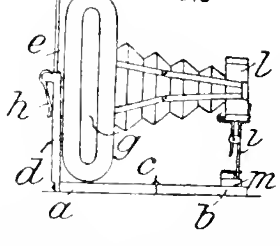


Consists in the employment of special shaped bars for use in a thermo-electric battery. The bar *b*, consisting of a nickel-copper alloy, is bent as shown and has a bar *c* cast on one end, this bar being an antimony-zinc alloy to which iron or cobalt has been added, in order to raise its melting point and to increase its mechanical strength. A copper strip *d* is attached to the nickel at its cold end, to act both as a support for, and to facilitate the cooling of, the nickel, whilst a copper plate is attached to the antimony for the same purpose. The short horizontal and vertical arms of nickel, which are heated to produce the thermo-electric current, may be replaced by silver, or an alloy of copper and silver, or copper coated with silver or gold; or the short horizontal arm alone may be so replaced.

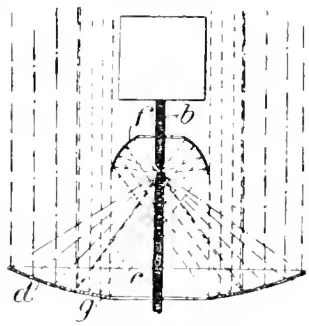
19,740. Photography. BECK, F., 12, Kaiserstrasse, Nuremberg, Germany. Sept. 9.

Camera stands.—Relates to a supporting-device for hand cameras, which is detachable from the camera. It consists of a base-board in two parts *a*; *b* hinged at *c*. At the back of the part *a* is pivoted a bracket *d* having a sliding bar *e* with an arm *f*, which is pressed down on the camera back *g* and clamped by the lever *h*. The front *l* of the camera is held by a spring clip which is pivoted to the front of the part *b*. When the support is not in use, the brackets *d*, *i* are folded down flat, and the parts *a*, *b* are folded together on the hinge *c*. The camera may be laid on its side on the support, when the front *l* rests on the block *m*, and the arm *f* is pushed further down.

FIG. 5



23,969. Arc-light projectors. ENGELSMANN, A., 11, Arminstrasse, Stuttgart, Wurtemberg, Germany. Nov. 3.



Reflectors for projecting light from alternating-current arc lamps. The light from the carbons *b*, *c* is reflected by two annular parabolic mirrors *d*, *f*, that falling on the mirror *f* being reflected again by an annular mirror *g*, within the mirror *d*.

N-Rays Stored up by Certain Bodies.

In the course of his investigations of the N-rays, Professor Blondlot, as pointed out in a note just read before the French Academy of Sciences, happened to state an interesting phenomenon. N-rays being produced by an Auer burner enclosed in a lantern, would traverse first one of the walls formed by an aluminium foil, to be concentrated afterwards by a quartz lense on phosphorescent calcium sulphide. The Auer burner having been extinguished and taken away, the phosphorescence would persist with nearly all its brilliancy, and on interposing a lead screen or moistened paper or else the hand between the lantern and the sulphide, the latter would be darkened; nothing was thus changed by the Auer burner being taken away but for a gradual decrease in the strength of the effect observed. Twenty minutes afterwards, they would still persist though being nearly insensible.

On closer investigating, the conditions of this surprising phenomenon, Blondlot soon noticed that the quartz lense had itself become a source of N-rays; as, in fact, this lense was taken away any action on the sulphide would disappear, whereas by approaching the lense, the sulphide was made to take a higher brilliancy. The author then exposed a quartz plate 15 mm. in thickness, the surface of which was a square of 5 sq. cm. to the action of N-rays given off from an Auer burner through two aluminium foils and black paper, when the plate would become active like the lense; as, in fact, the sulphide was approached, a phenomenon would be observed as if a darkening veil were taken away from it. In all these experiments the secondary emission from the quartz adds its effect to the N-rays directly emanating from the source. This secondary emission resides throughout the mass of the quartz, and not only on its surface, as by placing successively several quartz plates one on another, the effect is found to augment with each added plate. Islandspar, fluorspar, glass, &c., show a similar behaviour. A Nernst lamp filament will remain active for several hours after the lamp has been extinguished. A gold piece, on being laterally approached to the sulphide, submitted to the action of N-rays, would take a higher brilliancy; lead, platinum, silver, zinc, &c., would produce the

same effects. These actions would persist after the extinction of the N-rays, as in the case of quartz, though the property of emitting secondary rays does not penetrate but slowly the masses of metal.

Aluminium, wood, dry and moistened paper, paraffin, &c., do not show this property of storing up N rays. Calcium sulphide, on the other hand, will exhibit the same effect. This phenomenon accounts for the fact formerly observed by the author that the increase in phosphorescence under the action of N-rays require a certain time both to be produced and to disappear. As, in fact, N-rays are stored up, the different parts of the mass of sulphide will mutually strengthen their phosphorescence; as, however, the storing up is progressive, and as, on the other hand, the amount stored up is not exhausted instantaneously, the effect of N-rays falling on phosphorescent sulphide must increase slowly, and on being eliminated their effect cannot but progressively be extinguished. Certain stones picked up in a court where they had been exposed to the action of sun rays in the afternoon would give off spontaneously N-rays, preserving this activity for four days without any appreciable decrease. The surface of these bodies should, however, be very dry, the slightest layer of water being sufficient to stop the N-rays.

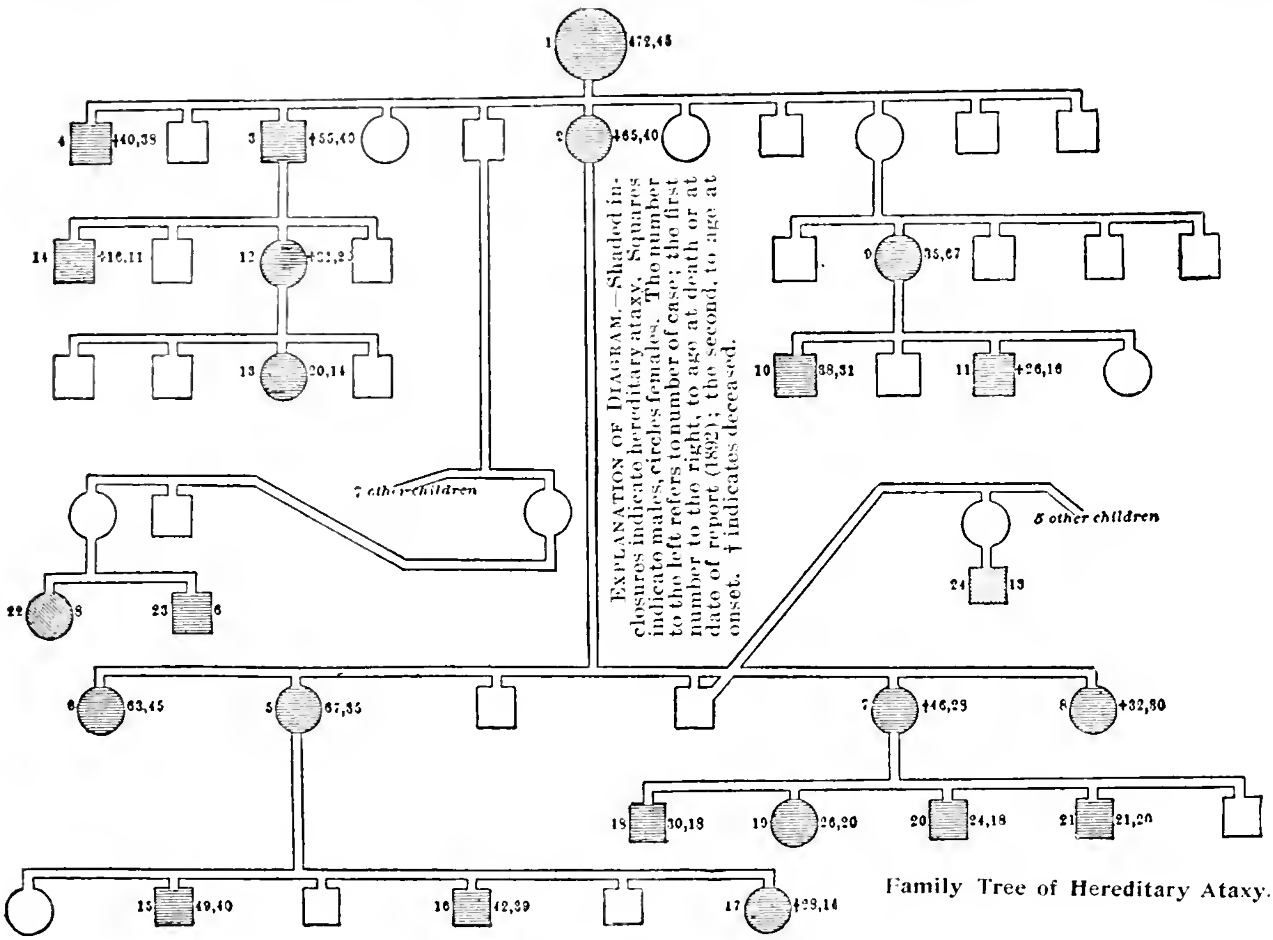
Hereditary Ataxia.

Among the latest volumes of the Decennial Publications of the University of Chicago is an interesting article by Lewellys F. Barker,* which includes a detailed description of the gross and microscopic findings in the brains and spinal cords of two brothers, dead of hereditary ataxia. Coloured plates illustrate the lesions of the spinal cord.

The article in question is extremely interesting to neurologists and medical men, and should be studied by those seeking the truths of well-deep neurological literature.

To the general scientific reader, who does not wish for technical details, the article brings home the lessons of care that parents should take in inquiring into the antecedents of those about to marry.

Dr. Sanger Brown says, and truly says: "Hereditary ataxia is a disease which may be traced through several (at least four) generations, increasing in extent and intensity as it descends, tending to occur earlier in life, and to advance more rapidly. It usually attacks several members of the same family. It occurs most frequently between the ages of 16 and 35. It shows no marked preference for sex, but it descends through females four times as frequently as through males. There is always considerable inco-ordination of all the voluntary muscles, and a sluggishness of the movements which they produce, when the disease is well established. This is usually noticed first in the muscles of the legs, but in a few months or years extends to the arms, face, eyes, head and organs of speech. Sometimes it occurs first in the upper extremities, and sometimes in the organs of speech."



Family Tree of Hereditary Ataxy.

There is little to be noticed in the macroscopic appearance of the cord as shown in the illustrations given, but microscopically, there is revealed marked degeneration in the grey and white matter.

The matter contained in this publication is accurate, and shows a profound insight and knowledge of the disease treated. By its study, we are enabled to know with certainty the neurone-systems principally involved in the individuals who are affected, though we are as yet entirely ignorant as to why just these neurone-systems should be picked out. The letterpress is clear and large, and the plates are extremely well done. We must congratulate the University of Chicago Press, Illinois, on the first series of their publications for the University of that city.—S.G.M.

* "A Description of the Brains and Spinal Cords of Two Brothers, Dead of Hereditary Ataxia of the Series in the Family Described by Dr. Sanger Brown," by Lewellys F. Barker. The Decennial Publications of the University of Chicago.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

MITES.

CECIL WARBURTON, M.A.

WHY do so few people collect mites? If we come to think of it the waste of energy among collectors is appalling, simply because nearly all are content to follow beaten tracks, where the chances of new discoveries are rare, and the same old observation is made for the fifty-thousandth time. There must be hundreds of people in England at this moment whose hobby is the microscope, who are skilful in the manipulation of small objects, and possess the collector's instinct, but whose imagination does not get beyond making neat preparations of diatoms or rotifers, or Foraminifera. And all the time here is a group of creatures ideal for the purpose, of great intrinsic interest, and concerning which a great deal remains to be discovered. Anyone who attacks the Acari with enthusiasm is pretty sure to add not one but many mites to the sum of human knowledge.

Many, no doubt, are deterred by the very fact that so little is known about these creatures. A moth, or a beetle, or a rotifer can generally be identified with comparative ease, because the researches of innumerable workers in these groups have been reduced to a form convenient for reference; but how is one to identify a mite? There is force in this argument, of course, though if the difficulties are greater, the chances of distinction are greater in proportion. In one family of the Acari, the Oribatidæ or "beetle-mites," moreover, this difficulty does not exist. Just consider, for a moment, the following facts.

Hardly a single Oribatid mite was recorded as having been captured in this country before 1879. In that year Mr. A. D. Michael published the first of a series of papers on these creatures, which he has since summed up in an admirable monograph,* fully illustrated, and containing every kind of information which can be of use to the collector. In this about a hundred British species are described. Remember that he was absolutely a pioneer in the subject, and worked at it almost single-handed in the leisure hours of five years of a busy professional life, and that very little indeed has been done since. He has given his followers a magnificent start; but is it likely that the mine he discovered and worked so enthusiastically is anywhere near exhaustion?

It would appear at first sight that the search for creatures which seldom exceed a millimetre in length, and are frequently very much less, must be laborious and irksome. The exact opposite is the case. Certainly it would be out of the question to go out into the open, armed with a lens, in search of individual mites, but there is not the least need for such a proceeding. These mites live under loose bark, in decaying wood, and especially in lichen and moss. The necessary equipment, then, for field work is not a lens at all, but a bag, or several bags. Thus armed the collector starts out to visit some likely spot that has occurred to him, a moss-grown wall, or a coppice where the trees are grey with lichen, and the ground carpeted here and there with patches of moss, and with such materials he fills his bags, bringing them home to work over at leisure.

* Publications of the Royal Society, 2 vols.

The study or "den" is now cleared for action. The apparatus consists of a pocket-lens, some large sheets of white paper (the white under-surface of remnants of wall paper is excellent for the purpose), a camel's hair brush, some ordinary microscope slides, and a low-power microscope arranged for opaque objects. I know of nothing better for the work in hand than a Stephenson's binocular with the one-inch objective. Portions of the moss are shaken out over the paper, and the *débris* allowed to remain undisturbed for a minute or so. Then most of the creatures shaken out of the moss will have found their feet, and will not be dislodged if the general litter is gently tilted off or blown aside. Numerous little specks are sure to be left adhering to the paper, and a moment's observation will show that some of them are slowly moving. Then the lens is brought into play, and the moving speck examined, and if it seems to be one of the creatures sought, it is transferred to a slide by means of the brush, and placed under the microscope for a closer study. But there are many other moving specks, and time is too precious just now to spend more than a moment or two over a single example, so we lightly place a cover-slip on his back, and thus loaded he is not likely to have moved very far when we have leisure to look at him again.

If the material is good, the hunt will be found exciting enough while it lasts, and the "bag" will be a certain number of tiny creatures making ineffectual efforts to walk along on the slippery surface of the glass slides under the superincumbent weight of the cover-slips. What is to be done with them? Well, the more thoroughly they can be examined while alive, the better, but those that are selected for the cabinet have to be killed and preserved in some way or other. In a collection of mites it is very desirable to have a double series of specimens, one series mounted as opaque objects, and the other rendered transparent. Whichever their destination, the preliminary operations are the same. The best way to kill them is to pop them into boiling-water. It sounds brutal, but it is instantaneous, and it has the advantage that it causes many species to extend their legs, and those that are not so obliging are generally in a more or less limp condition, and pretty easily manipulated. Now is the moment when the skill of the operator comes in. The mites are taken out of the water with the brush, and placed on white blotting paper. Then a single specimen is placed on a slide, turned on his back, and his legs arranged in the desired attitude under a dissecting microscope. A cover-slip keeps him in the proper position, and a drop of 2% solution of formalin is run in, a slight weight, such as a flattened shot, being superimposed to prevent the legs from curling up again. For the even distribution of the weight it is well to make a tripod with three specimens and the cover-slip.

Next day the creatures will be found to be rigid, and ready for dry mounting. If they are to be made transparent, carbolic acid is substituted for the formalin, which is removed by means of blotting paper as the acid is added. Some species will require a very much longer time in the carbolic acid than others, but they simply remain in till clear, when they are ready for mounting in Canada balsam, and the collector then has one specimen which shows how the animal looks when alive, and another in which minute points of the external anatomy may be studied. In this particular group of mites the chitinous cuticle is generally well-developed,

and the [illegible] lend themselves [illegible] excellently to dry mounting.

Very wet moss will not yield up its inhabitants on shaking, and it must be somewhat dried, but not too rapidly. If there is a great deal of coarse debris, as is sometimes the case, there is a danger of all the mites being swept off as the paper is tilted, and to obviate this it is not a bad plan to use some wide-meshed muslin as a sifter. The mites and the smaller particles of earth readily pass through the meshes, and can be distributed evenly over the surface of the paper with better chances of successful hunting.

(To be continued.)

Royal Microscopical Society.

March 16. Dr. Dukinfield H. Scott, F.R.S., President, in the chair. Prof. A. E. Wright communicated the gist of his paper "On Some New Methods of Measuring the Magnifying Power of the Microscope and of Lenses Generally." He described also the piece of apparatus which he had invented for taking the magnifying power of the microscope and for the rapid measurement of microscopic objects, which he termed an Eikonometer. It is placed over the eyepiece, without disturbing any of the adjustments of the instrument, and the object on the stage can then be instantaneously measured. The Secretary read a short note by Mr. F. B. Stringer "On the Separation of Ultra-Violet Light." Mr. Abraham Flatters exhibited on the screen a series of 60 hand-painted lantern slides illustrating botanical histology. The slides were photomicrographs of the actual micro-sections coloured accurately to represent the staining, and were much commended.

Queckett Microscopical Club.

The 412th ordinary meeting of the Club was held on March 18, at 20, Hanover Square, W., the new President, Dr. Edmund J. Spitta, V.P.R.A.S., in the chair. The Secretary announced that the new catalogue of the Club's Library, containing some 1,300 volumes, had been published, and was on sale at the price of one shilling.

Mr. T. G. Kingsford exhibited and described some glass tanks which he had constructed by a new method which did not involve the use of cement. These were primarily intended for use as light filters or screens, but they were also adapted for examination of pond life. The sides were formed of glass discs (clock glasses) kept at the desired distance by blocks of rubber cemented to a rubber band. This rubber band formed a lining to a similar band of flexible metal, the ends of which were drawn together by a screw. The pressure of the band upon the edge of the discs made a water-tight joint.

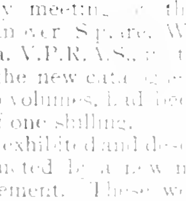
The Secretary read a note on the resolution of *Amphipleura pellucida*, by Lieut.-Col. John Thompson, of Brisbane.

Mr. D. J. Scourfield read a note, communicated by Dr. Vávra, on two Phyllopods from Bohemia, describing the life-history of these curious *Entomostraca*.

The Secretary then read extracts from a highly technical paper by Mr. T. B. Rosseter, F.R.M.S., "On the Genitalia of Taenia Sinuosa," the remainder of the paper being taken as read.

New Achromatic Condenser.

Messrs. J. Swift and Son have sent me for critical examination a new achromatic condenser of the form which is now rapidly superseding the ordinary non-achromatic type, which



has too small an aplanatic cone to be [illegible] for really critical work. Messrs. Swift's condenser is achromatic. Its power is [illegible] inch, and the aplanatic cone is between [illegible] and [illegible], with a numerical aperture of [illegible]. With the top lens removed the power is about 1¼ inch, but the aplanatic aperture, as always happens under such circumstances, is correspondingly diminished. The back lens is nearly 1 inch in diameter. It is not generally realised that to obtain the full aplanatic aperture of condensers of so perfect a type a definite thickness of slide must be used, and to obviate this and at the same time enable the best results to be arrived at, Messrs. Swift fit an improved form of correction collar to enable the necessary adjustments to be made. The price of the condenser, without mount, is 48s., and the correction collar is 15s. extra.

Notes and Queries.

I am glad to be able to announce with the present number the resumption of the "Notes and Queries" column, which, owing to circumstances beyond my control, but incident to the pressure of other matter in the columns of this journal, has hitherto been held over. In this column I shall endeavour, as heretofore, to answer (as far as I am able) all questions addressed to me which are of general interest. I wish also, if possible, to give an opportunity to my readers to publish short notes on matters appertaining to microscopy, which may interest them, or on which they may desire to interchange views, though, of course, limitations of space will necessitate my exercising a personal discretion in such matters. On many occasions, by the kindness of various correspondents, my predecessor, Mr. Cross, and I have also been able to distribute micro-material to applicants, and I hope that any readers who may have material of this sort suitable for distribution will give their assistance in this respect.

Magnification of Objectives and Eyepieces. (Major C. W. Tatham, Devonport.)

A [illegible]-inch objective professes to give an initial magnification (without eyepiece) of 120 diameters *with a 10-inch tube*. If it is corrected for and used with a shorter tube it will give a proportionately lower magnification, *e.g.*, with a 6-inch tube the initial magnification will be $\frac{6}{10}$ths of the foregoing, *i.e.*, 72 diameters. This magnification is increased by that of the eyepiece, which is, of course, itself unchanged, whatever the tube-length. Thus a [illegible]-inch objective used with an eyepiece that has itself a magnifying power of 5 will give with a 10 inch tube $120 \times 5 = 600$ diameters. With a 6-inch tube the total magnification will be $120 \times \frac{6}{10} \times 5 = 360$ diameters. Now come in two qualifications: First, that the objective is never quite in accordance with its professed magnification (based on the equivalent focal length), and is generally considerably higher; second, that the oculars also are not what they profess to be, and, moreover, that many makers will persist in rating them as if they and not the objectives varied in power according to variation in tube-length. For instance, your compensating eyepiece 12 may not be 12, but about half as much again, Zeiss assuming that the [illegible]-inch gives 120 magnifications at 6½ inches, and that this is multiplied by a 12 ocular, making a total of 1440 diameters, whereas, as a matter of fact, with this tube length, the 1440 diameters is made up of objective magnification $72 \times$ ocular magnification 20 or thereabouts! The compensating eyepieces for the long tube are therefore marked with their proper magnifications, and those for the short tube are the same oculars marked down as if they were 6½ times what they really are. With regard to testing the magnifications of objectives and oculars yourself, you will find detailed instructions in my article in the February issue. If you do not follow any point write to me again. Meanwhile, I need scarcely say that any power ocular can be used with any objective, provided the latter will bear it.

Mounting Diatoms in Gum Styrax and Monobromide of Naphthalene. (G. A. F[illegible], Bristol.)

I think you will find all that is necessary for mounting diatoms in these highly refractive media in *Carpenter*, page 521 (8th edition). The gum styrax can be dissolved in benzole or xylol and used as Canada balsam is used, save that more care must be taken to evaporate the benzole, or other solvent, before covering with the cover-glass. Monobromide of naphthalene is soluble in alcohol and ether, but in *Carpenter* it is recommended that the mount should be run round with a ring of [illegible] cemented with Heller's porcelain cement (which is not familiar to me), and finally closed with shellac.

Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St Barnabas Road, Cambridge.

The Face of the Sky for May.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.35, and sets at 7.20; on the 31st he rises at 3.52, and sets at 8.4.

Sunspots and faculæ should be looked for whenever it is fine; the positions of the spots with respect to the equator and pole may be derived from the following table:—

Date.	Axis inclined to W. from N. point.	Centre of disc, S. of Sun's equator.
May 1 ..	24° 16′	3° 58′
„ 10 ..	22° 22′	3° 0′
„ 20 ..	19° 36′	1° 52′
„ 30 ..	16° 11′	0° 41′

THE MOON:—

Date	Phases	H. M.
May 7 ..	☾ Last Quarter	11 50 a.m.
„ 15 ..	● New Moon	10 58 a.m.
„ 22 ..	☽ First Quarter	10 10 a.m.
„ 29 ..	○ Full Moon	8 55 a.m.
May 8 ..	Apogee	4 18 p.m.
„ 22 ..	Perigee	10 30 p.m.

Occultations.

There are only two occultations of fairly bright stars observable at convenient hours during the whole month. The particulars are as follows:—

Date	Star's Name	Magnitude	Disappearance	Reappearance
May 17	130 Tauri	5.5	7 27 p.m.	8 20 p.m.
„ 21	o Leonis	3.8	9 1 p.m.	9 26 p.m.

THE PLANETS.—Mercury will be observable for the first four or five days of the month; he should be looked for in the N.N.W. immediately after sunset at about an altitude of 15°. He is bright enough to be visible to the naked eye, but any slight optical aid will be of great assistance in detecting him in the strong twilight. The planet moves so rapidly that he is in inferior conjunction with the sun on the 13th.

Venus is a morning star throughout the month, rising only a short time in advance of the sun, and being for all practical purposes unobservable.

Mars is in conjunction with the sun on the 30th, and is therefore out of range.

Pallas is in opposition on the 16th, when the magnitude is 8·5. On this date, the minor planet has the same R.A. as γ Herculis, but is situated 6° north of the star.

Jupiter is a morning star, rising about 3 a.m.

Saturn is also a morning star, rising about 1.20 a.m. near the middle of the month; he is in quadrature with the sun on the 11th.

Uranus rises about 11.30 p.m. near the beginning of the month, and about 9.30 p.m. towards the end of the month. The planet is situated 4 mins. E. of 4 Sagittarii, and, observing with a low power eyepiece, can be seen in the same field of view as the star.

Neptune sets too soon for observation.

METEORS.—The principal shower during May is the *Aquarids*. This may be looked for between May 1-6; the radiant being in R.A. 22 h. 32 m., Dec. S. 2°, near the star η Aquarii.

THE STARS.—About 10 p.m. at the middle of the month the following constellations may be observed:

ZENITH . Ursa Major.
NORTH . *Polaris;* to the right, Draco and Cepheus; below, Cassiopeia; Perseus to the left.
SOUTH . Bootes and Virgo, *Arcturus* and *Spica* a little E. of the meridian; Leo to the S.W.
WEST . Gemini and Cancer; Taurus to N.W.; and *Procyon* to S.W.
EAST . Lyra (*Vega*), Corona, Hercules, and Ophiuchus; Cygnus to N.E., and Scorpio in S.E.

TELESCOPIC OBJECTS:—

Double Stars:—α Libræ, XIV.^{h} 46^m, S. 15° 39′, mags. 3, 6; separation 230″; very wide pair.

σ Coronæ, XVI.^{h} 11^m, N. 34° 7′, mags. 6, 6½; separation 4″·4; binary.

α Herculis, XVII.^{h} 10^m, N. 14° 30′, mags. 2½, 6; separation 4″·9. Very pretty double, with good contrast of colours, the brighter component being orange, the other blue.

δ Herculis XVII.^{h} 11^m, N. 24° 57′, mags. 3, 8; separation 17″.

Clusters.—M13 (cluster in Hercules) situated about ⅓ the distance from η to ζ Herculis, and is just visible to the naked eye. It is a globular cluster, and with a 3 or 4-inch telescope the outlying parts of the cluster can be resolved into a conglomeration of stars.

Brass Stripping.

ELECTROLYSIS, which deposits surface films of metal, has lately been put to an ingenious industrial use in stripping metals. Professor C. F. Burgess records a method of stripping superfluous brass from the joints of bicycle frames by using an electric current with a solution of sodium nitrate. The firm which has adopted the method used to make use of hand labour, which damaged the tubes, and afterwards of chemicals, such as potassium cyanide, which were expensive and slow. By this reversal of the principle of electrolytic deposition the brass can be cleaned off the tube joints in from five to forty-five minutes at a scarcely appreciable cost.

Calcium as an Industrial Metal.

PROFESSOR BORCHERS, of Aix-la-Chapelle, has succeeded, after overcoming many difficulties, in producing calcium by a new electrolytic process, by which, it is said, the metal can be obtained at a very low cost. It is now being extracted on a large scale, and there should be a great future before it, for, while of very common occurrence, calcium possesses certain properties, such as a great affinity for oxygen, which should make it a very desirable innovation in the iron industries. Exposed to moist air the metal rapidly becomes coated with oxide; but it nevertheless possesses many characteristics which may prove of value in the arts. It is fairly hard (harder than lead), can be hammered into leaf, and is very light, having a specific gravity of only 1·58, or much less than that of aluminium

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Radio-Activity and Radium.

By W. A. SHENSTONE, F.R.S.

II.

THE discovery that radium gives off, unceasingly, the radiations discussed a little later, and the early observation that in many respects these resemble the Röntgen or X-rays naturally suggested that possibly a few milligrams of radium might advantageously replace the comparatively complicated equipment required for the so-called X-ray photography, and accordingly this very interesting side of the subject has excited some interest. Whether radium rays will ever replace the usual apparatus for the production of Röntgen rays remains to be seen. But some very interesting results have undoubtedly been obtained, as my readers will gather from the following series of very excellent radium radiographs which I am allowed to introduce by the kind permission of Mrs. Gifford, of Chard, who has been working on this subject with great success. The conditions are given under each plate. Fifty milligrams of highly-purified radium bromide in glass tubes were used.

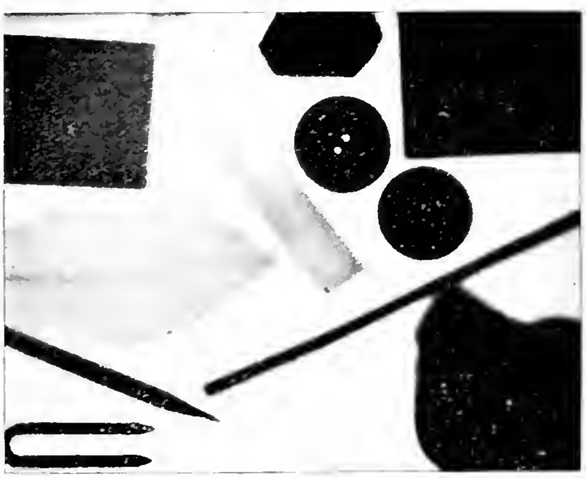


FIG. 6.—The radium salt was enclosed in two light bags. Exposure, 24 hours, at a distance of 9·65 cm. Medium plate. Most of the objects will explain themselves. The rectangular figures at the top are produced by blocks of glass, that to the right by uranium glass. The crystal near the larger block was fluor spar, the amorphous mass at the bottom on the reader's right is Kauri gum.

The trouble which arises in regard to the use of radium salts for work of this kind, I am informed, is this: That it is difficult, if not impossible, to concentrate the acting salt into a sufficiently small space. The radiations used, in short, are too diffuse.

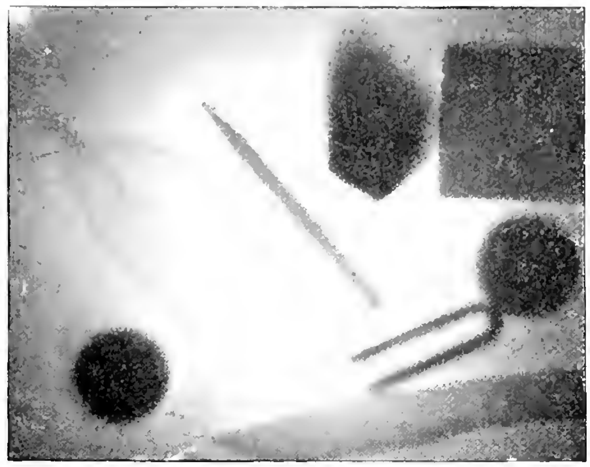


FIG. 7.—Taken under much the same conditions as 6, but through a plate of aluminium and with a 10 hours' exposure

The distinctive characters of radium which were first recognised were what are commonly known as "its radiations." But almost more wonderful and mysterious than these is the "emanation," which has been so carefully studied by Professor Rutherford, of Montreal.

The Radiations of Radium.—These have been classified as α, β, and γ rays. The last resemble Röntgen rays. They are unaffected by a magnetic field, and are intensely penetrative, passing through sheets of lead of considerable thickness, and these rays alone of the radium rays can penetrate the eyelids freely, so that they can be identified by the sense of diffuse light, of which one becomes conscious when a few milligrams of a radium salt are held near the tightly closed eye in a dark room.

One of the greatest achievements in physics during the latter half of the nineteenth century was the discovery, by Prof. J. J. Thomson, of Cambridge, and his colleagues, in the cathode stream of the Crookes' vacuum tube, of particles so small that about 700 of them would be required to produce a mass equal to that of an atom of hydrogen. These particles carry negative charges of electricity, and so are deflected by magnets; they will pass through thin sheets of metal, cause damp, dust-free air to form mist, and they make air conduct electricity. They move with a velocity equal to one-tenth that of light. They are often called "Electrons."* Now the

* This term was originally applied to the charge of electricity carried by an atom of hydrogen in electrolysis.

β rays of radium exhibit just these properties, only they move even more rapidly, sometimes, indeed, several times as rapidly as the electrons in the cathode stream, and are more penetrative. Hence the β rays may be considered to be "electrons."

The α rays were the last discovered. These are far heavier than the others, and are very easily stopped.

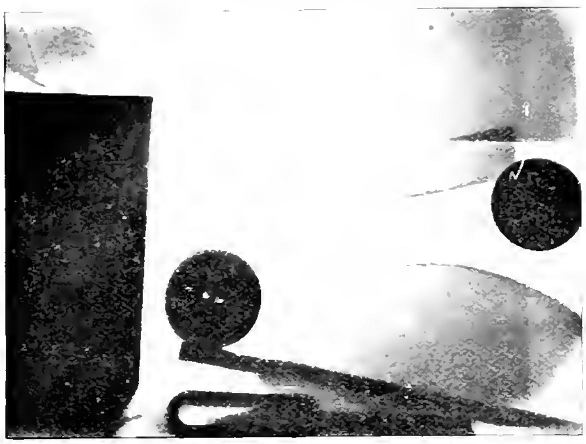


FIG. 8.—Taken without bags, at a distance of 4 cm. and with 5 hours' exposure. The dark shadow on the reader's left was produced by uranium; above it was a crystal of fluor spar. The rectangle at the top was caused by glass, and the dark object below this was a threepenny bit.

They can be deflected by powerful magnets, and the deflection is in the opposite sense to that of the rays of the cathode stream, which shows they carry positive charges. Sir William Crookes has shown us how to recognise them by letting them strike screens covered with phosphorescent zinc sulphide, as in the "spinthariscope."

Such substances as fluor-spar, kunzite, diamond, willemite, and barium platino-cyanide become luminous

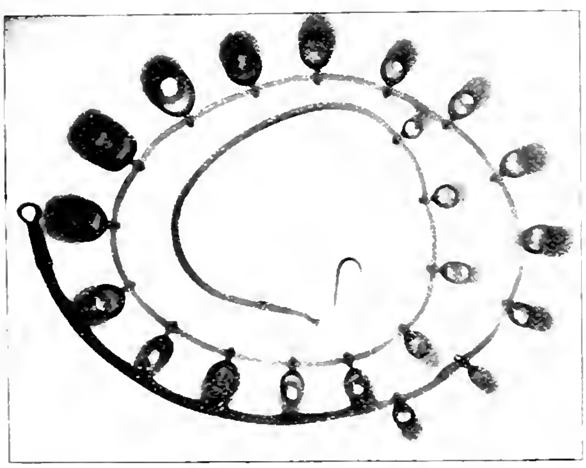


FIG. 9.—A necklace of various jewels set in metal. No bag. Taken with a rapid plate in three and half hours at a distance of 4.4 cm.

if the rays of radium fall upon them, much as they do under the influence of cathode rays, the effects produced being exceedingly beautiful.

The Emanation of Radium.—If radium be heated strongly, or if it be dissolved in water, a substance is given off which mixes with gases, and which, when freed from impurities, has the properties of a gas. This substance can be condensed at the temperature of liquid air in a glass tube, and is then phosphorescent. It can be re-evaporated. Its removal deprives the radium of 70 per cent. of its heating power, and the energy of the emanation is so great that it is calculated that if a whole cubic centimetre could be collected in one place it would probably melt the containing vessel. It is radio-active, and therefore must be supposed to be in a state of change, like radium.

The transformation of radium into its emanation and the connection between this change and the radio-active phenomena which accompany it have been investigated by Professor Rutherford. The phenomenon, as it appears to him, occurs in several successive stages. The heavy atoms—for radium has very heavy atoms—of radium disintregrate, throwing off positively charged particles, whose masses compare with those of hydrogen atoms, whilst new forms of matter lighter than radium remain behind, occluded as it were in the remaining radium. These residues are also radio-active and undergo further change of a similar kind stage after stage until at last α, β, and γ rays are all expelled.

Professor Rutherford suggested on certain grounds that probably helium would be found among the products of the disintegration of radium, which led Sir William Ramsay and Mr. Soddy to seek it. They find that though the

FIG. 10.—No bag was used in this case. Rapid plate. Distance 4.4 cm. Time of exposure, two hours.

emanation of radium when first liberated by dissolving a radium salt in water contains no helium, yet this element may be detected in the same emanation after a few days. For the present, therefore, we regard helium as the ultimate product of the disintegration of radium, or at least as the only such product yet detected.

The discovery of radium and of its unique properties raises some important questions:—

1.—Whence does radium derive its vast supply of energy? It has been suggested by some that it acts as a transformer, picking up energy in some way from its environment and giving it out again as light, heat, &c., in the course of its disintegration. Another school (and this predominates at present) regards radium as a form of matter endowed with relatively vast stores of potential energy: and it has even been suggested, originally, I believe, in order to compose certain differences between the physicists and the geologists on the subject of the age of the sun, that the energy of the sun would be accounted for by the presence of no more than three or four grams of radium in each cubic metre of its substance. Though, except such evidence as may be derived from the presence of helium in the sun, we have not much actual fact to support this latter hypothesis.

One of the latest contributors to this most interesting problem is Lord Kelvin, who finds the second hypothesis

difficult to accept, and points out that if two globular flasks, such as those in figure 12, one containing a black cloth A and the other a white one B be plunged in vessels of water and exposed to a source of radiant heat such as the sun, then the water in the vessel surrounding A will be hotter than that surrounding B, so long as the experiment is continued; as may be proved by the pressure on the mercury at C, or by observing thermometers placed near A and B.

Fig. 11.—Time, eight and a half hours. Distance about 7 cm.

Now the suggestion is that radium salts may absorb energy in this sort of way from some radiation in the surrounding ether, and that we know far too little as yet about radium and about the wave disturbances in the ether to dismiss this explanation of the mystery of radium from consideration before further experiments have been made.

2.—Is the production of helium from radium "a transmutation"; does it foreshadow similar transmutations among the better known and more plentiful elements, *e.g.*, the transforming of lead into gold or *vice versa*?

It is, I fear, impossible to consider the question in this form seriously till we know much more about radium.

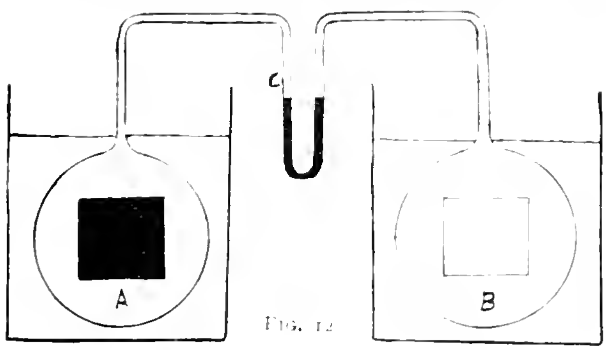


Fig. 12.

On account of its spectrum, the character of its salts, and their general alliance with the calcium group, radium ranks as an element. Yet if we are exact we cannot truly say radium has never been decomposed, for we explain its most characteristic properties by supposing that every specimen of radium salt is disintegrating spontaneously and resolving itself gradually into other forms of matter. Hence, it can hardly be regarded as an element in the sense in which oxygen is considered to be an element at this moment. The question before us, therefore, is this—Are the other elements radio-active like radium and its companions? Do these also, though we do not yet recognise the fact, undergo similar transformation, only at a far slower rate? If they do, or if we can prove that some of the lighter elements, *e.g.*, oxygen, sulphur, or sodium, do so, then the whole question of the nature of the elements, the very basis of chemistry, must come up for revision. At present the position may be taken, provisionally, to be something of this kind. The elements may, for the moment, be divided into two classes.

(*a*) Those which have relatively light atoms, and which are not, so far as we know at present, subject to disintegration, and are not radio-active, such elements, for example, as helium, oxygen, sodium.

(*b*) The radio-active forms of matter such as radium, uranium, thorium, which exist in larger particles and exhibit many of the characters of the elements, but which disintegrate, throwing off among their products atoms of elements of the more familiar type.

Whatever the truth may be, and it seems likely we may long seek the answer to this big question, it is clear that the study of radio-active matter must greatly enlarge, even if it does not revolutionise, our ideas about the processes by which the older and more familiar elements have been generated.

The Structure of Crystals.

By Harold Hilton.

It is proposed in this paper to give a brief account of the modern geometrical theory of crystal structure. The units of which a homogeneous medium is composed are called "molecules"; they are either chemical molecules

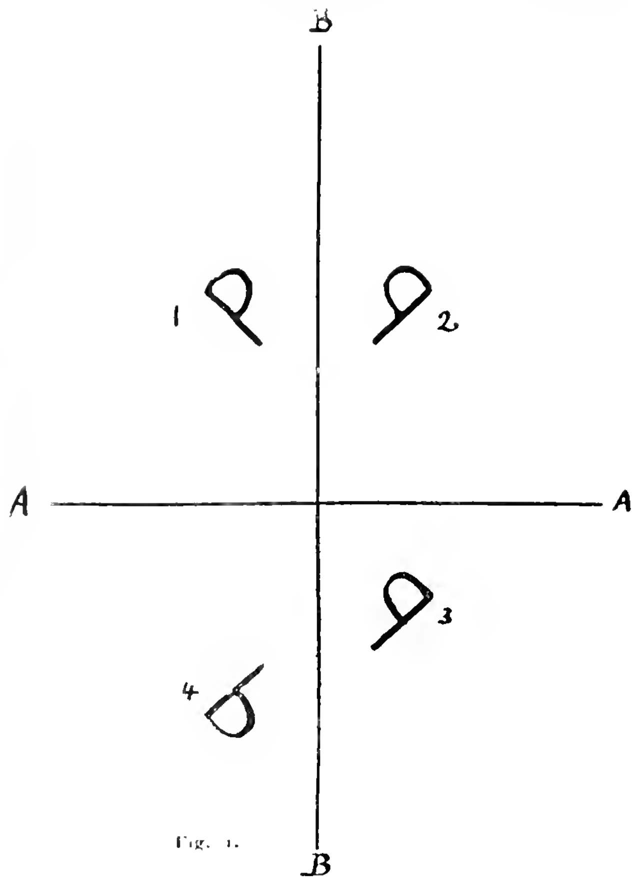


Fig. 1.

or definite aggregates of these. The molecules of such a medium are either all of the same kind (of the same size, shape, &c.); or else they are half of one kind and half of another, the molecules of the two kinds being related in the same way as a right-handed and a left-handed glove, that is, two molecules of different kinds may be placed so that they are reflections of each other in some plane. The two kinds of molecules are represented in the diagrams by the letters p and q. The molecules of the medium are arranged according to certain laws of "symmetry," that is, every molecule of the medium through a distance t parallel to the axis; (4) a reflexion in a plane called a "symmetry-plane"; (5) a reflexion in a point called a "centre of symmetry"; (6) a gliding reflexion, *i.e.*, a reflexion in a plane (called a "gliding-plane") followed by a translation parallel to the plane; (7) a rotation through an angle α about a line followed by a reflexion in a plane perpendicular to the line. Each of these movements leaves unaltered the distance between two given molecules; they may be considered as equivalent to only two distinct movements, (1) and (2) being particular cases of

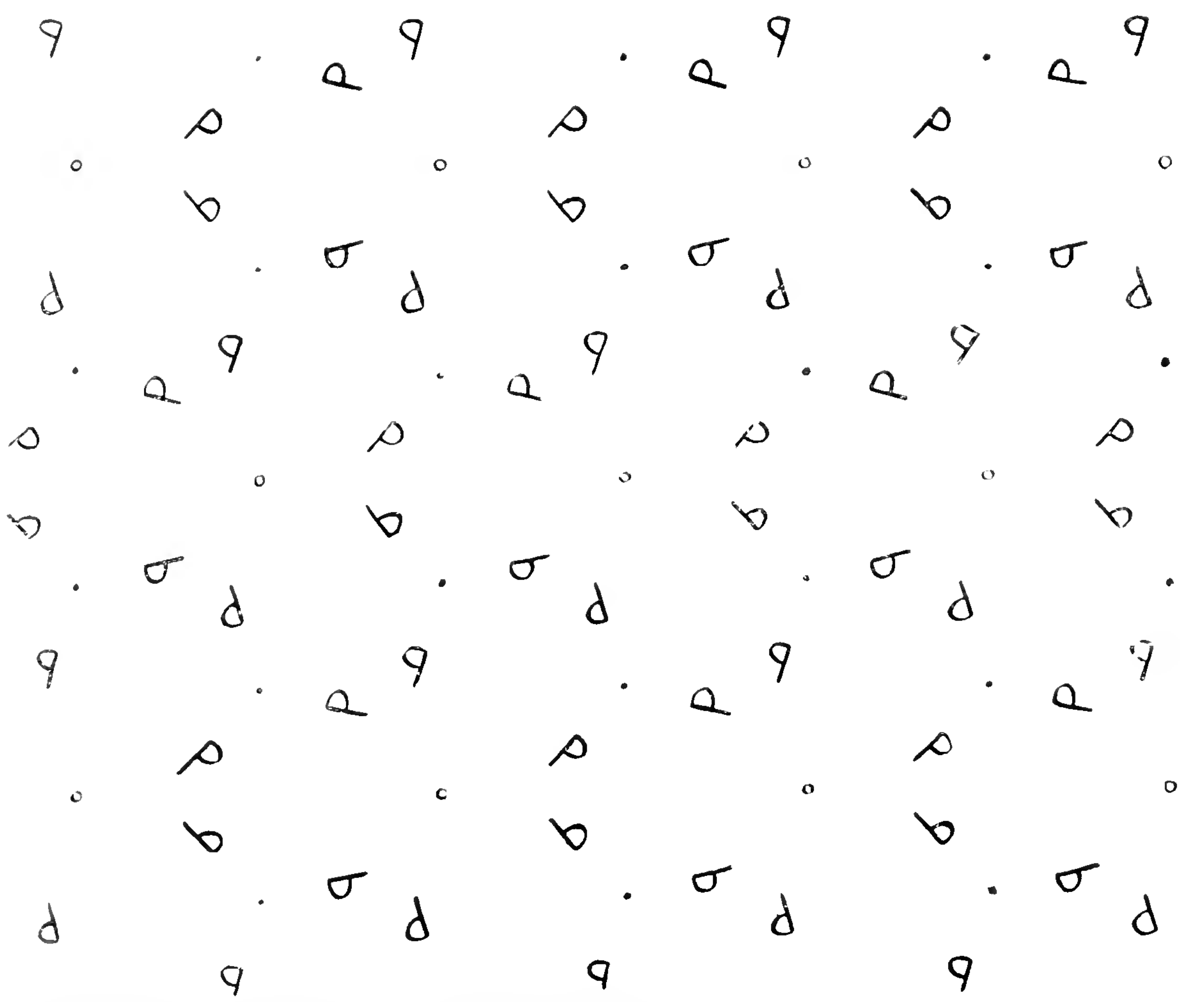


Fig. 2.

(supposed of infinite extent in all directions) is brought by certain so-called "movements" into the position previously occupied by some other molecule of the medium (the medium is said to be "brought to self-coincidence" by such a movement). These movements are of seven different kinds:—(1) a translation, *i.e.*, a shifting of each point of the medium through the same distance in the same direction; (2) a rotation through an angle α, about a straight line called a "rotation-axis"; (3) a screw, *i.e.*, a rotation through an angle α, about a straight line called a "screw-axis" followed by a translation (3) and (4), (5), and (6) of (7). The movements are illustrated by figure 1 in which the molecule 1 is brought into the positions now occupied by molecules 2, 4 by reflexion in the planes B, A (perpendicular to the plane of the paper); and into the position of molecule 3 by a gliding reflexion in B. The molecule 2 is brought into the position of molecule 3 by a translation, and of molecule 4 by a rotation through 180° about the intersection of A and B. A medium may be brought to self-coincidence by an indefinite number of different movements, but the presence of certain symmetry-elements

(*i.e.*, rotation-axes, screw-axes, &c.) necessitates or prevents the existence of other elements. For example, if a medium is brought to self-coincidence by a gliding-reflexion in a plane, it must be also brought to self-coincidence by a translation parallel to that plane. It is assumed that every crystalline medium is brought to self-coincidence by three very small but finite translations not lying in the same plane—a fundamental hypothesis which is justified by remembering that the physical properties of a homogeneous crystalline medium *in a given direction* are the same in every part of the medium. It follows from this assumption that the angle α of movements (2), (3), (7) must be a multiple of 60° or of 90°. It may be shown that the number of distinct arrangements of symmetry-elements is 230—a geometrical problem solved independently by Fedorow, Schoenflies, and Barlow. One such arrangement is shown in figure 2. The system of molecules there given is supposed extended indefinitely in the plane of the diagram, and over and under it at distances $2z$, $4z$, $6z$, . . . are placed similar and similarly situated systems so as to fill all space. It is evident that the collection of molecules so formed has the lines perpendicular to the plane of the paper, and passing through the points marked ○ and ● as rotation-axes (α = 120°), has the planes parallel to these axes, and passing through any two adjacent points marked ○ for symmetry-planes, and has the planes half-way between these symmetry-planes as gliding-planes. Such a collection of molecules is one of the six different geometrically possible ways of representing the structure of a medium (such as tourmaline, potassium bromate, &c.), which crystallizes in polyhedra having a rotation-axis for which α = 120° and three symmetry-planes through that axis making angles of 60° with each other (and having no other symmetry-element).

Again, suppose that half-way between two neighbouring systems of molecules in the collection just described, we insert the system obtained by rotating figure 2 through 180° about one of the points marked ○. The collection has the lines perpendicular to the plane of the diagram, and passing through the points marked ● as rotation axes for which α = 120°, the lines perpendicular to the planes of the diagram, and passing through the points marked ○ as screw-axes for which α = 60° and $t = z$, and the lines half-way between any two adjacent rotation-axes as screw-axes, for which α = 180° and $t = z$. The collection has the same symmetry-planes and gliding-planes as in the previous case, and has also gliding-planes through the screw-axes perpendicular to the symmetry-planes. The collection is one of the four different geometrically possible ways of representing the structure of a medium (such as zincite, wurtzite, iodyrite, &c.), which crystallizes in polyhedra having a rotation-axis for which α = 60° and six symmetry-planes through that axis making angles of 30° with each other.

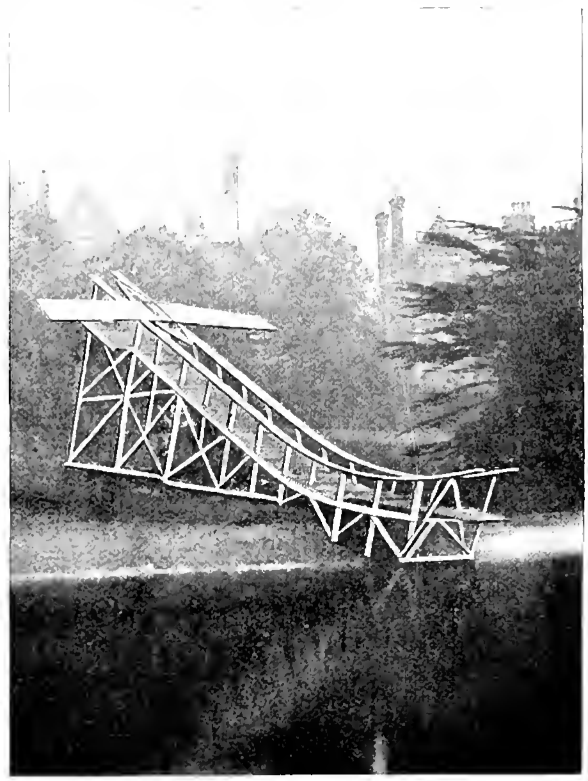
It must be remembered that it has not been proved that a collection of molecules, such as has been described, is one which can exist in stable equilibrium under the influence of the mutual attractions of the molecules. On the *dynamical* theory of crystal structure hardly any work has yet been done, but the *geometrical* theory is now fairly complete.

GRESHAM COLLEGE LECTURES.—A course of lectures on "Recent Solar Researches" was delivered at Gresham College during Whitsun week by Mr. E. Walter Maunder, F.R.A.S. The subjects of the lectures, delivered on successive evenings, were "Changes and Movements of Sunspots," "The Structure of Sunspots," "The Solar Atmosphere," and "Solar Periods and Influence."

Aeroplane Experiments at the Crystal Palace.

By Major BADEN POWELL.

IT has often been supposed that one of the greatest difficulties to be overcome before successful aerial navigation can be achieved is the practical balance of the apparatus in mid air. Whether or not this will really prove a stumbling block it is impossible, with our present experience, to state with certainty. Several inventors, it is true, have had considerable difficulties in the initial starting of their machines, which have had a way of toppling over as soon as they have been launched into the air. It seems just possible, however, that if the machine could



Starting.

be properly trimmed before starting, all such difficulties might be overcome. We know that small models, if dropped from the hand or lightly thrown forward, will easily upset, if not properly balanced, but which, if the weights be carefully adjusted beforehand, will fly steadily enough on their downward course. But it is extremely difficult to calculate the position of the centres of gravity and of pressure, and practical trial is the only certain method of getting this balance. How, then, is it possible to test practically the balance of a machine which we are loth to launch into mid air because we are afraid of its toppling over?

With a parachute or surface dropping perpendicularly, the weight should, of course, be in the centre of area; but if a more or less flat surface be progressing through the air horizontally, it is found that the centre of pressure advances towards the front edge, and, therefore, if the weight be in the centre, the plane will rapidly rise in front, and will soon overbalance and shoot down backwards. But the more rapidly the machine is travelling, the more does the

centre of effort advance. It would, therefore, seem to be necessary to shift the balance in accordance with the speed. The angle presented by the aeroplane also causes this point to vary, so that experiments with the tilting of the aeroplanes are also necessary.

It is often supposed that, in addition to what we may call the "passive" or "fixed" balance, we must take into account the action of the air currents on the wings. These may be the result both of the eddies caused by the progression of the planes through still air and of gusts of wind blowing against them.

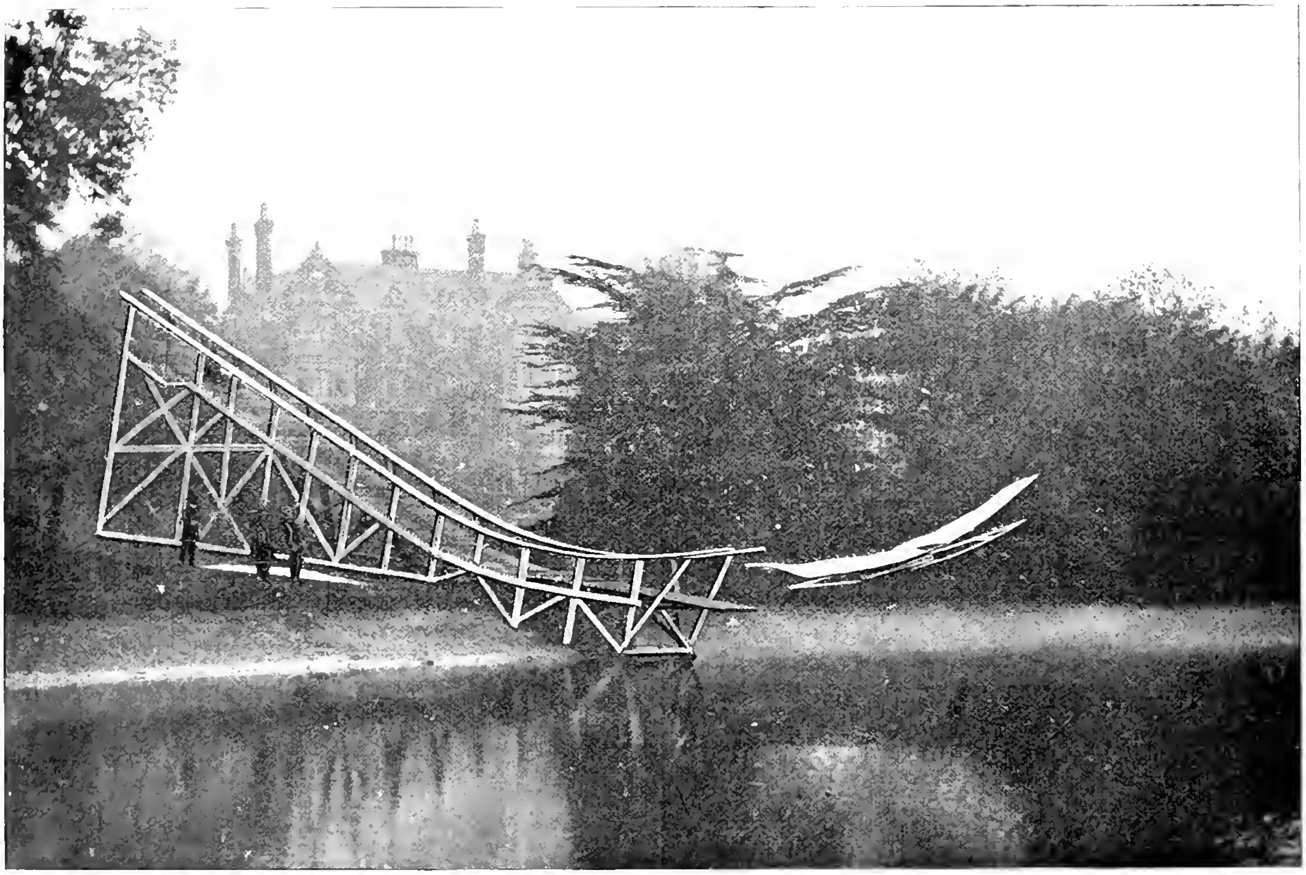
These actions and re-actions are little understood. Some authorities think that a large flying machine will be blown about like a piece of paper in the breeze, while others declare that a heavy machine progressing at a speed far greater than that of the wind will scarcely be affected by it.

Another problem calling for practical solution is that of steering. Vertical and horizontal rudders may seem a simple expedient, but it is doubtful if they form the most efficient means of steering. A bird has no vertical rudder, and tests with large gliding machines have proved them to be not entirely satisfactory.

It is therefore manifest that before we can build a proper airship we must make a series of trials with some apparatus progressing through the air and carrying an aeronaut to direct its course. Several experimenters have tried gliding machines, which have been designed either to soar down the face of a hill in the teeth of a wind, or to be drawn along by a string. But in addition to other drawbacks, these systems have the serious objection of being very dangerous to the operator. Already two of the principal experimenters in this line have unfortunately lost their lives through some small deficiency in their apparatus, and if tried over land there is always the danger that any small mishap may result in the machine losing its balance and precipitating its operator to the ground. Such machines, at all events as hitherto designed, cannot well be tried over water for several obvious reasons.

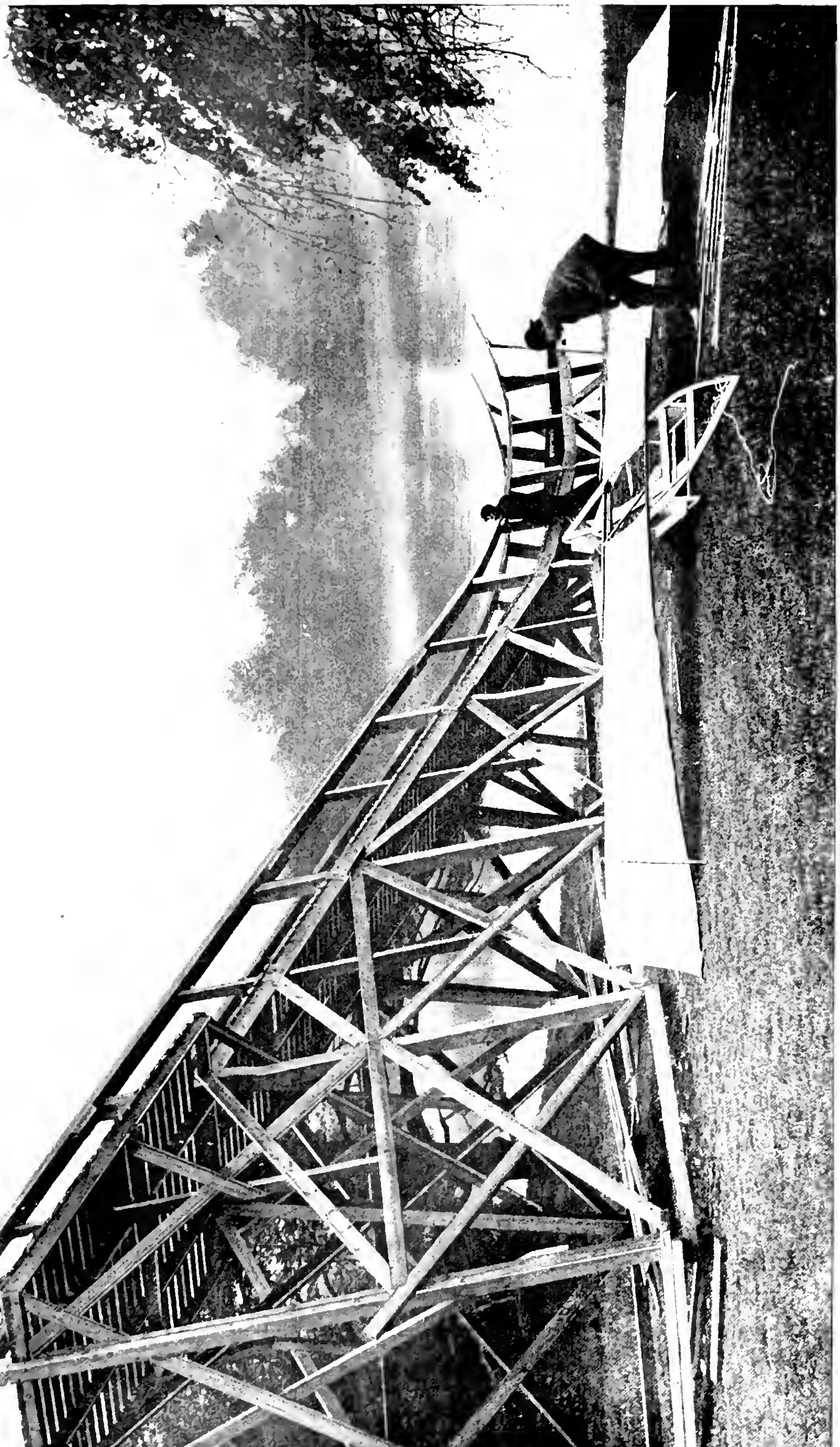
Moreover, such apparatus would usually progress comparatively slowly. Now, to support itself in the air an aeroplane must move along at a very considerable speed, and the questions of balance and of steering are undoubtedly much dependent on the rate of progress.

One of the simplest means of giving an initial speed to any body is to cause it to run down an inclined track and to shoot off into the air at the bottom. If means are adopted to prevent the machine from leaving the track before it gets to the bottom, and if it is then projected over a sheet of water, there can be but little chance of a serious accident.



Aeroplane leaving the Track.

I therefore decided, some months ago, to erect such a track, and conduct a series of experiments. Existing "water-chutes" at once suggested themselves as ready-made tracks, but, after examining several, and even making experiments with aeroplanes on them, I came to the conclusion that such were not suitable to the purpose. They are not steep enough to get up sufficient speed, they are not sufficiently turned up at the bottom to shoot the apparatus off in a horizontal direction, and rails and lamp-posts interfere with large wings. Besides, it would be difficult to arrange any method by which the aeroplane could be prevented from rising off the track before



Aeroplane and "Chute."

arriving at the bottom, which it is very apt to do in gusty weather.

By the courtesy of the Management of the Crystal Palace, the magnificent grounds of that institution have been placed at my disposal, and a most suitable spot was soon found beside the Intermediate Lake. Here I have had a large staging erected, of which the accompanying photographs will give a good idea.

Mr. C. J. Blomfield, the well-known architect, very kindly undertook to superintend the details of construction. This staging is of wood, the upper end being some 30 feet above the level of the lake. The incline is one in two, the lower end forming a curve of 60 feet radius. The "take off" is on an upward incline of one in ten, the lowest portion of the track being about ten feet from the outer end, which is six feet above the water level.

The rails are composed of solid slabs of oak securely bolted to the structure, and projected inwards so as to allow of runners engaging on their under sides as well as on the upper. They have a gauge of 2 ft. 6 in. These are carefully smoothed and greased to minimise friction. The flying apparatus consists of a boat, flat-bottomed, and with a considerably rockered stem, about 20 feet long over all, by 2 ft. 6 in. beam. From the sides of this project runners of oak to slide on the rails, and also some projections which are to engage the under sides of the rails in the event of the wind lifting the wings on one side, and thus prevent the machine being overturned or lifted upwards off the track.

The rate of descent is found to be 50 feet per second near the bottom, but this speed is, of course, diminished slightly during the upward incline before the boat leaves the track. An electric chronograph is to be fitted so that the speed can be measured over various sections of the track. The track is only just completed, and the proper man-carrying boat is still in hand.

The photographs show a skeleton pattern boat which was constructed to better get at the most suitable dimensions and shape. This, as may be seen, was fitted with two rectangular aeroplanes, each 12 feet by 5 ft. 6 ins., so that the area of this model is 132 square feet. Later on it is proposed to apply other shapes and forms of aeroplane to compare various patterns, and tails of different designs will also be tried.

I propose shortly to start making regular trials and shall hope to be able to give full accounts of these in the next number of "KNOWLEDGE & SCIENTIFIC NEWS."

Mr. J. Semenoy (see *Journal de Physique*, Feb., 1904) causes electric sparks to jump between two gas flames or a flame and a metallic electrode, or else between two metallic electrodes separated by a small gas flame. By this arrangement the glow is eliminated, so as to enable the spark proper to be examined separately. In fact the metallic vapours constituting the glow are blown away by the gas stream of the flame. The image of the spark is projected by means of a convergent lense on the vertical slit of a direct-vision spectroscope, the axis of which is perpendicular to the plane of the spark gap.

Semenov's experiments go to show that *electric currents in gases* are a *molecular phenomenon*; this would be in accord with Professor Bouty's researches on the dielectric cohesion of gases, which is also a *molecular* property.

Such currents are attended by the dissociation and projection of matter, the paths of which are in each point of the spark orientated in a plane perpendicular to the line of current. On account of the projection of matter taking place round the spark, a vacuum must be produced along the spark, the atmospheric pressure throwing into this vacuum the air and metallic vapour surrounding the electrode; this is obviously one of the causes of the transport of matter taking place from one pole to the other.—A. G.

The Development of Parasitism.

By J. REYNOLDS GREEN, Sc.D., F.R.S.

THE early ancestors of all plants now existing are generally held to have been aquatic organisms of fairly simple type, and of not very complex structure. Without going back to the extremely simple protoplasmic entity, whose nature cannot be said with certainty to have been vegetable rather than animal, we must admit the existence of a race of plants, each of which was capable of living for and by itself, of carrying on all the functions of nutrition, and of reproducing itself. The power of nourishing itself involved a further power; it must have been able, under the influence of the rays of the sun, to construct organic food material from the inorganic simple compounds furnished to it by its environment. The possession of this power was one of the earliest acquired marks of distinction between the animal and vegetable organisms, for though traces of it may be found in the former, they are but traces; and it is uncertain how far they actually pertain to the animal world. The vegetable organisms on the other hand, having once acquired the power, have retained and developed it till it is now recognised as their special and distinctive feature.

This peculiar property of constructing organic material from inorganic, on which all physical life depends, is associated with the presence in the vegetable organism of a peculiar green colouring matter, known as chlorophyll. The pigment is in nearly all cases found associated with peculiar differentiated portions of the living substance, known as plastids, which, though commonly small ovoid bodies lying in the general protoplasm of the organisms, may in the more lowly forms assume curious shapes. The power of food construction from inorganic materials and the presence of these *chloroplastids* go together, and the possession of what is often called this *chlorophyll apparatus* is the distinguishing feature of most plants.

Endowed with this apparatus, exposed to the rays of the sun, supplied with such simple inorganic substances as the carbon dioxide of the air, the water and the nitrates, sulphates, and phosphates of the soil, the plant can fight its own battles and reproduce its race.

In studying the vast field of vegetation that the face of the earth presents us with, however, we come across many types which are not nourished in this way, which have no power of food-construction, and which can only live, animal fashion, on organic materials ready made for them.

Looking more closely into the habits of such plants, we can distinguish between two classes of them, one thriving on dead, decaying organic matter, the other preying upon living organisms.

The latter form the great group of parasites, a degraded class which thrives by robbing other organisms of the food they have acquired, and by taking from them their own vital fluids, causing malnutrition and death.

The study of parasitism as seen in the vegetable kingdom illustrates very fully the law which is so well illustrated in the processes of the evolution of the races of both animals and plants, that disuse is followed by atrophy. Whether the parasitic plant lives at the expense of another plant or whether it attacks an animal organism, the result is the same—the disappearance of its

chlorophyll apparatus, the loss of the power of food-construction, and a consequent degradation of structure, always found accompanying such impotence.

The development of the parasitic habit has not taken place among one group of plants alone, and the parasitic plants are not therefore connected with one another by any ties of descent or inheritance. Parasitism has been acquired by simple and by complex plants, and apparently more than one chain of circumstances has led up to it.

Among the simpler families we find the great class of bacteria, or germs, in many cases parasitic, though others live on dead organic matter. Such as the latter are designated *saprophytes*, and in many cases they mark a halfway house to parasitism. A group of somewhat higher type is afforded by the fungi or moulds, which, like the former, include both saprophytic and parasitic forms.

From their structure these parasitic fungi are closely allied to the filamentous algæ or sea-weeds, from which it is clear that they have been derived. There are many families of these aquatic organisms, distinguished from each other by their peculiar methods of reproduction. There are corresponding groups of fungi, and from comparison of them there can be little doubt that the fungi have been developed from the algæ which they resemble.

The process of their development, though based upon existing forms of both, can be fairly satisfactorily traced. We have, however, only *probability* to point to, for we have not very satisfactory transitional forms. The main difference between the two is the presence of the chlorophyll apparatus in the one and its absence from the other. This involves, however, a change of habit of life which has led to modification of the structure of the plant body.

It is not very difficult to see how the parasitic habit probably arose in these lowly plants. Their bodies are not differentiated into definite members like the higher plants, but are little microscopic spheres or flat plates, or filaments. Many of them now are found to be living in a sort of association with each other, not helping each other further than by supplying mechanical support. If we imagine a comparatively large form supporting a number of smaller ones, we can see that its death and decay would present to those adhering to it a considerable amount of organic material ready for consumption. Such a source of food supply may well have been utilised, for its absorption would relieve the adhering plants from much labour of construction. A saprophytic habit thus assumed would be likely to be permanent, and the manufacture of the now unnecessary chlorophyll apparatus would gradually die out.

The forms thus acquiring saprophytism have been many and varied in their form. The great majority have been filamentous, consisting of long threads known as *hyphæ*. These threads permeate the mass of the decaying organic matter. Such are many of our common moulds, which are developed now so easily upon syruppy substances.

The passage from this comparatively harmless way of getting food to the destructive form of parasitism is not very difficult. We can trace it in many of the fungi which are at our side to-day. Instead of waiting for the death of the plant to which the fungus is attached, the latter in many cases kills it by secreting and pouring out a toxic substance or poison which causes a local death of the tissue with which it comes into contact. Into this dead nidus the filaments of the intruder then grow, and so its establishment takes place in the interior of its host, such growth being preceded by a destruction of the latter, the materials so formed being the food of the fungus. This conduct marks a stage very near to the establishment of the true parasitism, which involves only the feeding of the intruder on the materials of the host plant, prior to death and decomposition. This change of nutritive method soon follows, the intruder gaining the power to assimilate the juices of its host without any such decomposition. Then the gradual weakening of the host is the sign of the invader, which has ceased to manufacture the toxin or poison which was at one period a necessary phase in the process of the nutrition.

We cannot point to organisms which are at present in the early stages of this transformation of nutritive processes, but certain fungi can be found which have hardly passed beyond that of the loss of the chlorophyll apparatus. One which is known as *Pythium* attacks young lettuce seedlings, causing the disease known as *damping off*. This illustrates the change; it has no green colour, and gains all its food from the living tissue of the seedlings, but its structure, and especially its modes of reproduction, are strikingly like those of the algæ to which it is related. The reproductive cells which it forms, their shape, and structure, the mode of their formation, and their general behaviour are strikingly algal. Among the various species of the genus we find forms which are gradually losing these algal peculiarities, and are beginning to show the degradation of structure which always is associated sooner or later with the parasitic mode of life.

Besides these pathogenic forms, bacterial and fungal, associated emphatically with a diseased condition of the host plant, Nature shows us others which are much higher in the scale of organisation, belonging indeed to the highly organised flowering plants. When we pass in review a series of these parasites we find the same succession of events, the acquirement of parasitism accompanied by a loss of the power of constructing organic substance and a progressive degradation of the whole organism.

In tracing the development of the habit among these higher plants we find suggestions that it originated in a different way from that which we have noticed among the fungi. Saprophytism is not unknown among the flowering plants, but it has apparently had no part in the development of parasitism. The origin of the latter must be looked for in the close relationship often found existing among plants which were originally nothing more than neighbours, by virtue of which they came to help one another in a peculiar manner in the struggle for existence. This relationship, known as *symbiosis*, is a union of two plants for their mutual benefit. It is seen in many cases, conspicuous among which we have the *lichens*, peculiar organisms consisting of an alga and a fungus living in close relationship with each other, each contributing a share to the well-being of the compound organism.

The origin of such symbiosis among the higher plants can be seen in the case of a group of plants often known as *root parasites*. They include many members of the Natural Order *Scrophularineæ*, e.g., the yellow-rattle which grow in pastures and waste ground. The roots of these plants are growing freely among the roots of the other plants, the grasses, &c., of the pasture. Coming into contact with these, the irritation of the contact causes a swelling to arise upon the root of the rattle, and from this growth delicate filaments emerge which penetrate the grass root and set up an intimate relationship between the two, which become so far united that liquid matter can pass with comparative ease from the one to the other. The relationship so set up is not particularly harmful to the grass; indeed, it seems to be beneficial to both symbionts, bringing about in a way an equalisation of the nutritive material that both are engaged in making. It involves

no diminution of the chlorophyll of either, and no degradation of structure.

A further stage in the acquirement of the parasitic rather than the symbiotic habit is exhibited by the mistletoe and its allies. We are most of us familiar with the mistletoe, an evergreen plant with pale greyish-green leaves, found growing on the poplar, apple, &c. It arises in all cases from the germination of seeds deposited by buds in the bark of the branches of the host. The young rootlet of the mistletoe inserts itself into the bark, and penetrates the soft tissues of the cortex as far as the young wood. Subsequent growth and development, which are accompanied by the co-incident growth and increased thickness of the branch, lead to the establishment of a very close union between the tissues of the two, and as the plumule of the seed develops and the upper portion of the mistletoe plant increases, the two are so firmly joined that the organic food of the host is easily absorbed by the intruder. The relationship is still symbiotic, for while during the greater part of the year the host plant feeds the mistletoe in preponderating measure, in the winter, after the leaf-fall of the host, the evergreen guest contributes to the nutrition of both. The plant shows, however, the beginning of the inequality of symbiotic effort which is the antecedent of parasitism. Co-incident with this we find the beginning of the degradation of the chlorophyll apparatus, the mistletoe possessing leaves of very grey-green colour.

The inequality thus established can be traced a stage further in the genus *Orobanche*, the so-called *broom-rapes*, which are far from uncommon among our wild plants. They consist of a large fleshy stem ending in a spike of flowers; the stem bears a few almost rudimentary leaves which are almost brown, having but little green matter in them. The broom-rape is found seated upon the roots of some other herbaceous plant, and is furnished with a greatly thickened and swollen base by which the attachment is made. The swelling is due to the absorption of nutritive matter from the host plant, which is now almost the only source of food possessed by the intruder. Parasitism is practically established; the chlorophyll apparatus of the broom-rape is rudimentary and abortive, and the burden of feeding both falls upon the host plant which suffers in consequence.

The common Dodder shows as yet another stage. The plant infests many herbaceous plants, especially clover. The seed germinates on the ground, and the young embryo twines itself around some neighbouring stem. Having established its hold, it forsakes the ground, and in all its subsequent growth it twines more and more fully round its host. The long twining stem bears no leaves, and contains no chlorophyll. At intervals along its course it puts out sucking root-like filaments, which perforate the host and set up a close union between the tissues of the two. So fed, the Dodder flowers and seeds, altogether at the expense of its host.

Our own flora shows us no more complete instance of a parasite than this. In some tropical areas a parasite can be met with which lives entirely wrapped up inside the tissues of its host. The degradation of its structure is complete, for its anatomical complexity is reduced to a very close resemblance to the hyphal network of a fungus. Here and there an outgrowth of the plant penetrates the surface of the host plant, and develops into a flower, which in some cases has an enormous fleshy body. The parasitic habit now dominates the plant; it lives only to produce its flower, it has lost all trace of normal structure, it obtains everything from the internal tissues of its host, and stands before us indolent, atrophied, and yet triumphant.

The Autobiography of Herbert Spencer.

The late Mr. Herbert Spencer has written his "Autobiography" (Williams and Norgate) in a vein of exceeding seriousness. Other men who have written their autobiographies endear themselves to their readers by their unconscious revelation of character, even their human weaknesses. Mr. Herbert Spencer had no human weaknesses; he appears in his autobiography as the personification of abstract thought. It is true that he was a dutiful son; indeed, in speaking of his mother, he approaches more nearly to tenderness than on any other occasion, but even here he displays that detached clear-sightedness that characterises all his relations in life. "Of my mother's intellect there is nothing special to be remarked," he comments, and adds with that one touch of feeling already mentioned, "speaking broadly, the world may be divided into those who deserve little and get much, and those who deserve much and get little. My mother belonged to the latter class; and it is a source of unceasing regret with me that I did not do more to prevent her inclusion in this class." The reader is fain to share her son's retrospective sympathy for Mrs. Spencer when he learns something of her husband's irritating characteristics. "He held, for instance, that everyone should speak clearly, and that those who did not ought to suffer the resulting evil. Hence, if he did not understand some question my mother put, he would remain silent; not asking what the question was, and letting it go unanswered. He continued this habit all through life, notwithstanding its futility." Mr. Spencer arraigns his earlier Huguenot and Wesleyan progenitors in the same scientific spirit, tracing in his own character kindred traits derived from them. "That the spirit of Nonconformity is shown by me in various directions, no one can deny," he says in conclusion. "The disregard of authority, political, religious, or social, is very conspicuous. Along with this there goes, in a transfigured form, a placing of principles having superhuman origins above rules having human origins, for throughout all writings of mine relating to the affairs of men, it is contended that ethical injunctions stand above legal injunctions."

The elder Mr. Spencer postponed his son's education on grounds of health; but, desultory as it was, at thirteen he had acquired considerably more general knowledge than is common at that age. Of Latin and Greek, he knew "nothing worth mentioning." Of English grammar or history, he was entirely ignorant, and the deficiency in his literary education makes itself felt in the roughness of his English; but, on the other hand, "my conceptions of physical principles and properties had considerable clearness, and I had a fair acquaintance with sundry special phenomena in physics and chemistry." A far more important mental acquisition, and one in which school education is conspicuously deficient, was what Mr. Spencer describes as the habit "of intellectual self-help," which his father was continually inculcating. Shortly after he was thirteen Herbert Spencer went to continue his education at the house of an uncle, where he seems to have derived more benefit from mental and moral discipline than the actual acquisition of knowledge. Soon after his return home he entered on a brief career as a teacher, his father's profession. In 1837 he obtained a post under Mr. Charles Fox, Permanent Resident Engineer of the London division of the London and Birmingham Railway during its process of construction.

"I arrived in London on the 8th November, 1837. . . . The Queen, who had but lately succeeded to the throne, and was not yet crowned, dined with the Lord Mayor in the City on the 9th of November, and the occasion called for a State Pageant. It was the only Royal procession or display of allied kind which I ever saw." He adds later: "I was quite alive to the responsibilities of my post and resolute to succeed. During

the whole of my sojourn in London, lasting over six months, I never went to a place of amusement; nor ever read a novel or other work of light literature." It was surely this incapacity for healthy recreation, ingrained by his education, that was largely responsible for the ill health and nervous strain with which Herbert Spencer had to contend during his later years. One cannot read without a smile his grave animadversions on the companions with whom he was thrown at the engineering offices at Worcester, to which he subsequently went. "Unlike the pupils of Mr. Charles Fox, quiet youths, carefully brought up (two of them being sons of dissenting ministers), the junior members of the Birmingham and Gloucester staff belonged largely to the ruling classes, and had corresponding notions and habits." . . . "The superintendence was not rigid, and the making of designs was interspersed now with stories not of an improving kind, now with glances down on the passers by, especially the females, and resulting remarks; there being also a continuous accompaniment of whistling and singing, chiefly of sentimental ballads." Among these young men Herbert Spencer was, however, able to form one congenial intimacy, which we remark upon because it instances again that detached quality of mind already mentioned, that habit of appraising his fellows, even his most intimate friends. "He was the son of Dr. Jackson, at that time Foreign Secretary to the Bible Society. Of somewhat ungainly build, and with an intellect mechanically receptive, but without much thinking power, my friend was extremely conscientious." . . . "Association with a man whose intellectual powers were above my own would have been more advantageous," he adds.

About this period, Herbert Spencer notes that religious beliefs were slowly losing their hold, "the creed of Christendom being evidently alien to my nature, both emotional and intellectual." "Criticism," he continues, "had not yet shown me how astonishing is the supposition that the Cause from which have arisen thirty millions of Suns, with their attendant planets, took the form of a man, and made a bargain with Abraham to give him territory in return for Allegiance." "I had not at that time," he continues, "repudiated the notion of a deity who is pleased with the singing of his praises, and angry with the infinitesimal beings he has made when they fail to tell him perpetually of his greatness," an extraordinary crudeness of statement "of the Creed of Christendom," which can only be accounted for by Herbert Spencer's Nonconformist antecedents.

In 1841, Herbert Spencer returned home, partly to pursue a course of mathematical study, and partly to carry out his father's idea of an electro-magnetic engine. Neither scheme was pursued. It is curious to find him continually commenting on his "constitutional idleness," which "has taken the form of inability to persevere in labour which has not an object at once large and distinct." The years that followed, though they were apparently desultory and futile from the point of view of material advancement, were of crucial importance in the history of Spencer's subsequent career, and in determining the bent of his genius. He instances, as a step in his mental development, the letters on social questions contributed by him to the *Nonconformist*, an organ of the Advanced Dissenters, letters which originated in political discussions with an uncle, who introduced him to the editor:

> "Had they never been written, Social Statics, which originated from them, would not even have been thought of. Had there been no Social Statics, those lines of enquiry which led to 'The Principles of Psychology' would have remained unexplored. And without that study of life in general, initiated by the writing of these works, leading presently to the study of the relations between its phenomena and those of the inorganic world, there would have been no System of Synthetic Philosophy."

Meanwhile, he was besides variously occupied journalistically and otherwise, and in 1850 appeared his first book, "Social Statics: or the Conditions Essential to Human Happiness Specified." "Assuming happiness as the end to be achieved, it regarded achievement of it as dependent on fulfilment of conditions, conformity to which constitutes morality."

After the appearance in 1855 of his second book "The Principles of Psychology," he suffered from a serious breakdown in health which enforced a long period of idleness. To these two books Mr. Spencer appends with characteristic aloofness of mind two hypothetical reviews, criticising his own arguments and summarising his doctrines. As soon as his health was sufficiently recovered, he set to work upon his "System of Synthetic Philosophy." He describes himself at this time as "a nervous invalid" "having only precarious resources," and his undertaking, so monumental a task, necessitated a heroic struggle with physical weakness. After the publication of the first early part of the work he found himself obliged to decide upon the abandonment of his design. His parents were in need of his support, and he had already trenched considerably upon his small capital. The proposal immediately called forth the following generous response from J. S. Mill.

"It is right that you should be indemnified by the readers and purchasers of the series for the loss you have incurred by it. I should be glad to contribute my part, and should like to know at how much you estimate the loss, and whether you will allow me to speak of it to friends and obtain subscriptions for the remainder."

The proposal was eventually declined. The death of the elder Spencer lessened his son's responsibilities, and American admirers placed 7000 dollars to his credit in public securities. Of Herbert Spencer's relations with his contemporaries we have hardly space to speak. One instance must suffice of the shrewd but merciless clear sightedness with which he estimated the mental and moral calibre of his acquaintances. Of Carlyle he says: "He has, strange to say, been classed as a philosopher! Considering that he either could not or would not think coherently never set out from premises and reasoned his way to conclusions, but habitually dealt in intuitions and dogmatic assertions, he lacked the trait which, perhaps more than any other, distinguishes the philosopher properly so called. He lacked also a further trait. Instead of thinking calmly, as the philosopher above all others does, he thought in a passion. It would take much seeking to find one whose intellect was perturbed by emotion in the same degree."

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S.

In introducing the first of the Photographic sections to the readers of "Knowledge," it is fit that I should say something as to the general character of the matter that they may expect to find in this part of the journal. Everyone may now be considered to take a practical interest in photography, just as everyone knows how to write his own language intelligibly. Therefore it will be my endeavour to deal with matters connected with the practice of the art as opportunity seems suitable. A few perhaps take an interest in photography for its own sake; and as the pure science of to-day may be regarded as the applied science of to-morrow, I shall hope to draw the attention of readers to notable items of progress in photography, even though their immediate application may not be very obvious. But in all cases it will be my endeavour as far as possible to meet the needs of all who take the trouble to read these notes, and to enable me to do this I shall welcome any suggestions or questions of general interest, and the account of any photographic experiences, whether in connection with scientific work or the general practice of the art.

The Rendering of Colour.—It is a notable sign of the times that the only films now made by the Kodak Company are colour sensitised or isochromatic. Although

colour-sensitised plates have been available for many years, and in photo-micrography and other scientific work they have long been considered as indispensable, even those who know the advantages that they offer too often appear to lose their critical sense as soon as they take their cameras out of doors. It is a mistake to suppose that the proper rendering of variously-coloured objects is an artistic matter; it belongs to the realm of science, and the reason that it is neglected is that we have got so used to the conventional errors in the representation of coloured objects in monochrome by photography that they do not offend the eye as errors in outline do. Another reason is, I think, that it has so often been represented of some colour-sensitised plates that they do not need a coloured screen, that many who have seen the results of their use without that assistance have been unable to find any advantage in them. There is no available colour-sensitised plate that will give an advantage worth having in ordinary work by daylight, even if detectable by critical examination, unless it is used in conjunction with a coloured screen. The sensitiveness to blue light is so overpoweringly great that the little added sensitiveness to green, yellow, or red is lost unless the blue light is reduced. And the deeper the colour of the screen the more correct will the resulting photograph be so far as the use of well-known commercial screens (or light filters as some call them) is concerned. By the injudicious use of dyes it is easily possible to absorb so much blue that this colour photographs as if it were black, while yellow and green will appear as if white. It is safest not to use a screen that requires the exposure increasing to more than about eight times, unless one has some guarantee that it is suitable. At about this stage, and beyond it, it becomes necessary to adjust the screen to the particular plate that is to be used. It is a mistake to suppose that a coloured screen renders exposures outrageously long. The screen that probably requires a greater increase of exposure than any other on the market, the "Absolutus" screen made by Messrs. Sanger Shepherd, and Co. to suit Cadett's spectrum plates, and it requires exposures out of doors to be increased about forty times, as a rule only needs the giving of a few seconds' exposure instead of a fraction of a second. For hand-camera work, it is well to have a screen that needs the exposure to be doubled, and also one that requires it to be increased to four times or more for use when circumstances permit. It is well worth the little extra trouble involved if only for the sake of the improvement that will be manifest in the skies, especially when these are partly or wholly cloudless.

Catatype. This interesting process seems to be still in the doubtful stage so far as its practical uses are concerned. It was patented nearly three years ago by Messrs. Ostwald and Gros, and is one of the results of Professor Ostwald's investigations in connection with catalysis. Finely divided metallic platinum or silver causes the decomposition of hydrogen peroxide when merely brought into contact with it. It, therefore, a photograph in which the image consists of metallic silver or platinum is flooded with a solution of peroxide of hydrogen in ether, when the ether has evaporated the peroxide will be decomposed where it is in contact with the finely divided metal, and if the original is a negative there will be on it an invisible positive image in hydrogen peroxide. By pressing such a treated photograph against a gelatine film for about thirty seconds, a notable quantity of the peroxide will be absorbed by the gelatine, and such a "print" can be developed, or made to give a visible result in many ways. An alkaline silver solution will give a black image of metallic silver, an alkaline lead solution a brown image of lead peroxide, and so on. By treating such a print with a ferrous salt, the peroxide will convert the ferrous salt into a ferric salt and this will render the gelatine insoluble in water. If the gelatine has been mixed with a pigment, as in ordinary carbon tissue, and the print is developed by means of warm water as an ordinary carbon print is developed, it is stated that this method of producing carbon prints gives the print ready for development in about two minutes instead of the time usually required to sensitise the tissue with bichromate, dry it, and expose it behind the negative. The process may also be available for photo-mechanical work, for it is stated that gelatine that has absorbed peroxide of hydrogen will take up a fatty ink after the manner of chromated gelatine that has been exposed to light. It is to be hoped that we shall soon hear more of the practical applications of these methods.

(*To be continued.*)

The Antiquity of the Constellations.

TO THE EDITORS OF "KNOWLEDGE."

GENTLEMEN,—Let us hope that Mr. Maunder may tell us more about the origin of the constellations. The late Mr. Proctor was very bold and fixed the date at which they were invented (or revealed) at 2170 B.C., neither more nor less. Mr. Robert Brown, too, one would gather, was given (like Balbus) to rashness in speculation.

Mr. Maunder puts the approximate date at 2800 B.C. But some difficulties suggest themselves on the brief summary of his arguments, *e.g.*:—

(1) The centre of the space not included in the ancient constellations must have been the S. pole of the period when they were designed.

But do we know all the ancient constellations? A recent work, "Sphaera" (referred to below), gives, not 48, but some 150. Many are duplicates (and the variants are curious and interesting). Others are quite unidentified, *e.g.*, the market place, the two skulls, the stag with two snakes in his nostrils.

(2) The tradition of the four royal stars marking the colures.

But Regulus was a "royal" star for an obvious astrological reason. It was the heart of the royal beast, the lion, and was supposed to rule the fates of kings. (The star called Cor Hydrae, or the serpent's heart, denotes trouble through women.) If the Persians called other stars "royal" they may have had equally good (or bad) reasons of the kind.

(3) The date gives the only symmetrical position for the actual constellations of the Zodiac.

But there is a strong tradition that they were originally eleven, not twelve, and their position otherwise is far from symmetrical.

(4) The ascending signs at this date faced east; the descending west.

But why did three face nowhere in particular? Manilius gives amusing explanations.

(5) There are traditions of Taurus leading the Zodiac.

Possibly, but the familiar lines of Vergil in the first Georgic do not prove this.

It is not safe to base arguments on poetry, and, in fact, Seneca finds fault with the agriculture of this very passage (Ep. 86): "Our Virgil considered effect more than truth and wished to please his readers, not to teach farming." But the astronomy is right enough. Virgil is thinking of April, and Ovid's lines (Fast IV. 88) are the best explanation:—

Nam, quia ver *aperit* tunc omnia, densaque cedit
Frigoris asperitas, fetaque terra patet;
Aprilem memorant ab aperto tempore dictum

or

When that Aprille with his showres soote
The drought of March had perced to the roote.

According to Columella the Sun enters Taurus on April 17, and the dog sets with the sun on the last day of the month.

My principal object in writing this letter is to call attention to the German book "Sphaera," by Franz Boll, Leipzig: Teubner, 1903, above referred to, which gives new Greek texts, and sheds a flood of light on the history of the constellation signs.

The new texts are astrological, and indicate a promising field of investigation.

One vexed problem which is incidentally solved is that of the so-called Zodiacs of Dendera, which, though neither Zodiacs nor pictures of the heavens at any date, are shown to be of capital importance in a new direction.

I am, Gentlemen,
Your obedient Servant,
T. K. Arnold.

23, West Side, Wimbledon.
Feb. 18, 1904.

[Mr. Arnold has not quite understood the significance of Dr. Franz Boll's valuable work. The new Greek texts discovered and discussed by him have no direct bearing on the origin and antiquity of the constellations. They were found in late mediaeval manuscripts and consisted of excerpts from astrological writers of the first to the fifth centuries of our era. The chief interest attaches to the discovery of some texts of the writings of the Babylonian astrologer Teucros; perhaps better known to English readers as Zeuchrus, who lived about the Christian era or in the first century A.D. Mr. Arnold has apparently been misled by Dr. Boll's use of the word "sternbilder." The additional constellations of which Mr. Arnold speaks are mostly not "constellations" at all in the sense in which we ordinarily use that word, i.e., groups of actual stars, but are simply decanal symbols. The "decans," or portions of the ecliptic ten degrees in length—three therefore to each sign of the Zodiac—go back to a great antiquity, but are necessarily of much later date than the original mapping out of the constellations. For the actual constellations are most irregular in length, and the division into decans implies that the ecliptic had been previously divided into twelve equal parts, bearing only a rough relationship to the constellations and not corresponding to the actual stars, though the new "Signs" naturally took their names from the old "Constellations." The symbols attached to the 36 decans are therefore not truly stellar at all; they partly look back to the Egyptian system of placing the year under the protection of 36 deities, partly to the association of each of the twelve zodiacal constellations with its "paranatellonta" or extra zodiacal constellations, and partly to the desire of the astrologers to have a fuller supply of prognostics to work with than the twelve signs alone could give. Thus the "Agora," or Market Place, mentioned by Mr. Arnold, was in the second decan of Libra; and was clearly but an enlargement of the idea suggested by the Balances, of buying, selling, and weighing. It is not a question of an actual star group bearing that name. It simply indicated the middle ten degrees of longitude of the "Sign" Libra. The "two skulls" are neither new nor unidentified. Dr. Boll himself points out that they are mentioned by Albumasar, one of the best known of mediaeval astrologers of the Ninth Century A.D. They are placed, usually with other symbols, in the third decan of Libra, and quite possibly are nothing but a very corrupt form of the "Heavenly Twins," Adonis and Aphrodite, Tammuz and Istar, i.e., the Sun and Moon. There is no reason for surprise that so much variation is found in the symbols attached to the decans and their subdivisions. They never had the authority, for they had not the antiquity, of the constellations, and many, no doubt, owed their origin to the caprice of individual astrologers, or to an imperfect understanding of symbols employed in foreign systems. Dr. Boll's work supplies some interesting cases of the wide differences shown in manuscripts professedly based upon the same original authority.

As to another point raised by Mr. Arnold, the constellations of the Zodiac, so far as we can trace them with certainty, were always accounted twelve, even if only eleven separate figures were shown. The Scorpion had a double portion allotted to him in schemes which did not display the Balance; sometimes, as in the Greek scheme, his claws extended to the feet of Virgo; sometimes a second scorpion took the place now held by the Balance. But it will be noted that Libra is recognised by the astrological schemes, so that whenever the Balance was introduced it must have been before the working out of systematic astrology, and before the division of the "signs" into "decans."

Mr. Arnold's explanation of the name of Regulus does not lead us far. It leaves unexplained why a lion was designed in that part of the sky. But if Regulus got its name of "King" when it marked actually the highest point of the ecliptic, on account of its pre-eminent position, it would not be very unnatural that the form of the "King of Beasts" should be figured out round it. The Southern Fish and the Scorpion are certainly not "royal" beasts at all; the Bull questionably one; so that no astrological reason is likely to have gained that title for Fomalhaut, Antares, and Aldebaran. But their relation to the other colures being so similar to that which Regulus held to the colure of the summer solstice may well have caused the title to be extended to them; especially as the date indicated agrees so well with that suggested by the unmapped space in the south.

The three signs which face nowhere in particular are Libra, which had no face to turn, and Pisces and Gemini, which had each two, looking in opposite directions. Doubtless the ancients had some special reasons for making the Fishes swim away from each other, and the Twins face each other, but I fear it would be only guess-work to suggest them now. It is clear that the nine remaining signs, which have all one face apiece, are arranged as I state.

Is not Mr. Arnold a little inconsistent in saying that "it is not safe to base arguments on poetry" and then immediately proceeding to adopt the method he condemns? And how does he know that Vergil was thinking of April? The real significance of the familiar quotation from the Georgics lies in the fact that not only did the Ram actually "open the year" in Virgil's time, but that it was generally recognised as doing so. The quotations from Ovid and Columella are as little relevant to the question before us as the one from Chaucer.

Dr. Boll's examination of the planisphere of Denderah is sufficient to show what has long been recognised, that that monument can throw no light upon the antiquity of the constellations. E. Walter Maunder.]

The Mechanical State of the Sun.

By Professor R. A. Sampson, F.R.S.

A glance backwards at the theories which have attempted to give a reasoned and connected view of current knowledge of the Sun suggests that knowledge and theory are complementary, so much more detailed and precise was theory when little or nothing was known. It was from little more than the darkness of the sunspots, with Wilson's theory that they were depressions in the photosphere, that Sir William Herschel elaborated his doctrine of a Sun with inhabitants and luxuriant vegetation;* and if it is now clear that we shall need an imagination as intrepid as Herschel's to realise the state of the Sun, it is no less clear that it must be a vastly more creative imagination. Thanks to photography, of which M. Janssen has for so long given us such admirable examples, thanks above all to the spectroscope, which, in its latest applications in the spectroheliograph, actually maps out the forms of clouds of hydrogen and calcium at different levels of the Sun's atmosphere, we seem to have the means of gaining some real knowledge of the structure as well as the composition of the Sun's atmosphere. Nor are these the only signals that theory should hold its peace. A fresh discussion of the statistics of sunspots and prominences by Sir Norman Lockyer has shown

* The doctrine is not yet extinct; I have met persons, hardly in middle life, who learnt it at school, and held it without question

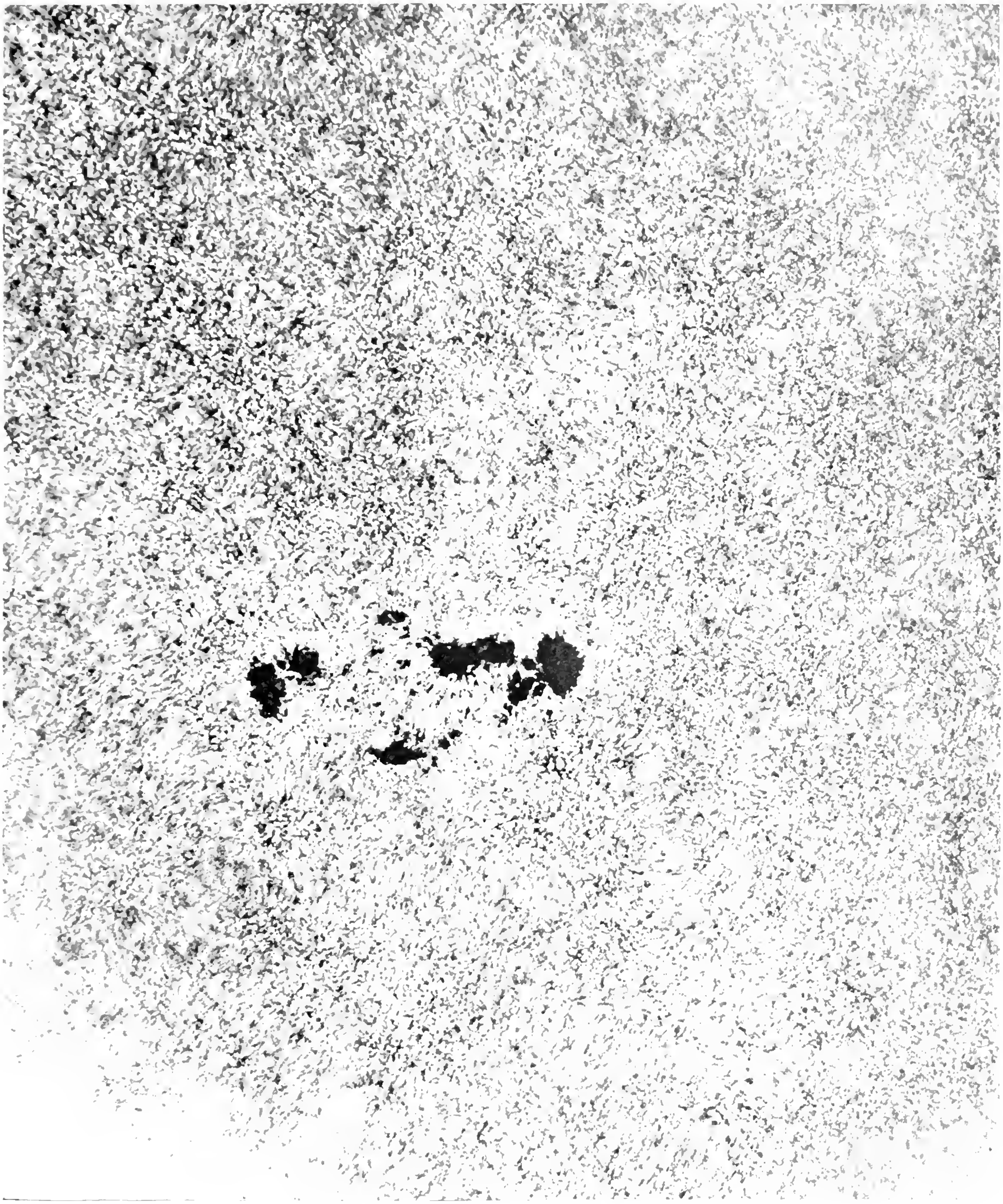
that the familiar eleven-year period is resolvable into the separate progresses of three or four simpler elements, which overlap one another and severally arise and disappear within seven or eight years; and a consideration of the Stonyhurst magnetic records by Father Cortie has served to prove how indefinable in the present state of our knowledge is the bond connecting magnetic storm with solar outbursts. In the presence of rapid and promising developments on the one hand, and increasing doubt upon the other, reserve in formulating any theory is unavoidable. No great confidence can be placed in arguments not based upon considerations which are of the widest generality, and cannot under any circumstances be falsified; such, for example, as the laws by which such a body must gradually condense under the influence of gravitation and loss of heat. Even here it is necessary to make somewhat sweeping assumptions before any precise conclusions can be drawn, and there is considerable disagreement among the results at which different authors have arrived. Yet I believe some plain and necessary outline can be drawn which will cover many of the most prominent facts. Though such an investigation relates more directly to the conditions prevailing within the body of the Sun than to the state at the surface, with which it might at first appear that we were alone concerned, its bearing upon the latter question is intimate. Thus Professor Schuster has said that the main difference between stars which show a spectrum like our Sun, filled with metallic absorption lines, and those which, like Vega, show only the absorption of hydrogen, is neither more nor less than the more thorough mixing up of the atmospheres of the former; "if we could introduce a stirrer into *a Lyrae* there can be no doubt whatever that the low-temperature lines of iron would make their appearance." If this be true, the stirrer we are seeking consists of more or less violent convection currents, and in order to form a just estimate of how efficient these may be we should study that instability which in great or small degree is always present where convection currents exist.

Instability with bodily interchange of material does visibly exist in the Sun, and must do so, or else its face would soon be covered with a dense mask of relatively cold matter; it is radiation which sets this instability up, and the key to understanding it is some comprehension of the process of radiation. For example, it should be realized very clearly that a comparison of the radiant energy emitted by two bodies is no comparison of their temperatures unless they are in similar states; thus a solid body maintained at a certain temperature radiates sensibly as from its surface; but if it be finely divided, and its parts scattered, it will radiate enormously faster from the same temperature, since its surface will be enormously multiplied. Hence, if a sunspot appears nearly black in comparison with the rest of the disc, or if, as in M. Janssen's photographs, we see the whole surface mottled over with minute brilliant spots upon a darker background, the simplest explanation is that the brighter parts represent matter diffused in cloud, and the darker parts are relatively dense and conglomerate.

In my opinion, the whole internal state is dominated by radiation, for apart from this source of loss of heat, there is no reason why the body should not settle down to any law of distribution of its matter in which the density did not increase from the centre outwards. But I must profess myself a total disbeliever in the state of affairs which it is commonly asserted would in consequence arise.

This state is Lord Kelvin's well-known "Convective Equilibrium" of temperature. Discussing in 1862 the state of the earth's atmosphere, and observing how winds and other currents mingled together with great rapidity portions of air which had been widely separated, Lord Kelvin adopted the hypothesis that the temperature at different levels must be such that this indifferent mingling should not change it; in other words, the excess of heat-energy possessed by a portion of air at a lower level of the atmosphere, and at consequently greater pressure and density, must be just sufficient to expand the same portion to a pressure and density in equilibrium with those at any level above to which it may be transported. The same law he afterwards adopted as regulating the whole internal state of the Sun, and many other eminent authorities have followed him, the latest and not the least of whom is Professor Schuster. If it is true of the Sun, we must allow that the Sun's density diminishes somewhat rapidly from the centre outwards, while the temperature from the surface to the centre rises with a great rapidity, which is maintained without much decline right throughout the whole body and reaches millions of degrees centigrade before one-tenth of the radius has been measured.

No doubt we must be prepared for some extravagances in theorising upon matters so little known, but it is at any rate safe to keep as far as possible from temperatures measured in millions of degrees; and in spite of the long acceptance of the theory of convective equilibrium in the Sun and the formidable array of authority by which it has been adopted, I confess I can find no reason why it should be supposed to exist. On the contrary it appears to me that if we can imagine it to be artificially set up, it would require forces to maintain it for which the circumstances make no provision. For if a body of gas were arranged according to this law, behind some screen which prevented it from losing energy by radiation, and the screen were then removed, what would happen? All portions would commence to lose heat, the outer portions very rapidly by mere radiation; but the inner portions also, in part by radiation, because they were less screened outwards than inwards, but chiefly because the outer chilled portions which had already lost the heat that allowed them to maintain themselves at the higher level descended upon them and shared in their stores. This would go on without any attempt on the part of the body of gas to restore the state of convective equilibrium, because no instability would occur which would give rise to convective currents mingling together the matter from separated regions, until the body had departed materially from the rapidly-varying density of convective equilibrium and had passed that of a density uniform throughout the mass. Even then the currents would only be proportionate to the degree by which a uniform density was overstepped, and except at the outer surface, where it is impossible to escape from a high degree of instability and consequently violent convective currents, the density would apparently be left in a state which might perhaps fluctuate a little, but would be but very little removed from a state of uniformity. It would follow that the temperature was also substantially the same throughout the bulk. Or again, if we reverse our attitude and suppose a body set up with density and temperature nearly uniform throughout its body, but on the whole very slightly increasing outwards and therefore liable to slight convective currents—excepting at the surface—and ask what forces would be found which could materially disturb such a state, none can be mentioned. Radiation which appeared as an acting cause tending to set up such a state will be inoperative when that state is attained—excepting again the surface—and conduction also, if we chose to consider it, would be inoperative with



Photograph of a Group of Spots and of the Granulations of the Solar Surface, taken at the Meudon Observatory, 1884, April 1, 10h. 46m., G.M.T.

a uniform temperature. At the surface, however, there will be a wide difference; between the rapid loss by radiation and the rapid restoring currents from below, no permanent or equable balance can be maintained; the slow currents from within, which tend to make their way outwards under the tendency of the bulk to settle down with greater condensation in its outward parts, here burst forth with a violence which all can see, and having parted with their energy, return nearly as precipitately.

Radiation, then, is the dominating factor in the distribution of temperature and density within the Sun, and it will be noticed that in showing it to be so no assumption has been made as to the law by which it proceeds. If we wish to put our conclusions in a numerical shape, such assumptions cannot be escaped. For example, Stefan's well-established law of radiation, according to the fourth power of the absolute temperature from the surface of a "black body," does not apparently permit any conclusions to be drawn as to the law by which a gas would radiate. Between imperfect physical knowledge on the one hand, and mathematical difficulties on the other, nothing can be done except to produce a more precise illustration of the foregoing argument, and to show that the conclusions will stand scrutiny. This I have done in a paper published some nine years ago.*

There are two other general problems presented by the Sun which appear to invite solutions upon general mechanical principles. The first of these is the eleven-year period in solar activity. But as to an efficient cause for it, or even any calculable phenomenon which could follow its phases in a similar period, we seem to be still quite in the dark. An attempt has been made to reproduce such a period by a combination of tidal effects produced by Jupiter and Saturn; but the result is unconvincing, because the tide produced must be at most very minute, and the coincidence of period is dependent upon a hypothesis for which no reason can be assigned as to the relative intensity of effect of the two planets. In fact, we know as yet too little of the phases of this cycle to hope to theorise upon it successfully. Any real explanation must cover the more detailed description which Lockyer has given, to which allusion has been made above.

The second problem to which I refer is the law of rotation of the surface, by which the equator of the Sun rotates most rapidly, and parts in lower latitudes rotate more rapidly than parts in higher latitudes. The law was discovered by Carrington from motions of the spots, and was at first believed to refer to the spots, but in the hands of M. Dunér, the spectroscope has proved that the property belongs to the whole photosphere. If we do not mark off the photosphere from the rest of the body of the Sun, this law contains, I believe, no mystery. If we suppose that in the course of its condensation in the past the inner strata of the Sun were to be found rotating faster than those outside them, it can be proved that as soon as the body had condensed to a compact fluid consistency so that the internal friction of its relative motions came into play, a law of rotation identical with that exhibited in the Sun would develop. But perhaps more striking, though less complete than a mathematical proof, is an illustrative experiment that was carried out some years ago by M. Bélopolsky, who filled a glass globe with water, carrying powdered stearin in suspension, and whirled it on a whirling machine until a uniform rate of rotation was taken up by the whole. The glass was then stopped and the motion of the water as exhibited by the particles in suspension was watched. The circumstances were now in substance just such as I have sketched above, and the apparatus exhibited just such relative motions as the Sun displays, individual particles travelling spirally from the equator towards either pole, with an angular motion which was less for greater latitude, ultimately passing inwards radially into the body. This last detail seems to convey also a suggestion of activities limited to special zones that may prove fruitful.

*Memoirs Royal Astronomical Society Vol. LI.

Photograph of the Solar Granulations.

In the accompanying plate we give a reproduction on a reduced scale of part of one of the magnificent photographs of the solar surface, recently published by M. Janssen in the "Atlas," which we noticed in the April issue. The wonderful manner in which the minute structure of the solar photosphere is brought out in M. Janssen's superb photographs is due principally to the care which he has taken to secure two points—the one that the photograph shall be taken by light which is practically monochromatic, so that the image is as sharp as it is possible to obtain it; the other that the exposure shall be extremely short, so as to accentuate minute differences of brightness in the most luminous portions of the disc. It will be noted that the photograph is so under-exposed that in the present reproduction the penumbræ of the spots are perfectly black. They were not absolutely featureless in the original, but were exceedingly faint, the darker portions of the sun being thus sacrificed in order to secure the maximum of detail in the more brilliant parts. The intensely granular nature of the disc and the thatch-like structure between the spots are very clearly seen. This particular region of the sun does not show any strongly developed instance of the blurring of the granules; but here and there small smudged regions show themselves.

The original of this photograph was taken on April 1, 1884, at $10^h 46^m$ G.M.T. The group of spots in the centre of the field is the one numbered 1343 in the Greenwich series. It was a sudden outburst, the day of the photograph being only the second of its existence. Its area at the time was 177 millionths of the sun's visible hemisphere, or slightly over 200 millions of square miles. The group increased in size with great rapidity. On April 2 its area was nearly five times as great as on April 1, and by April 6 the group was one of the largest seen during the entire 1882-1884 maximum. It returned to the visible hemisphere on April 21. During the thirteen days that it was under observation at this return, it was gradually diminishing in area; the leader spot being as usual a circular spot of regular structure, and much more stable than the rest of the group. Before the group disappeared at the west limb on May 3, the leader was the only survivor. The leader was seen again, still as a well marked circular spot, during two further returns. It slowly diminished in size, and was last seen on July 12, when it had shrunk to an area of no more than six millionths of the solar hemisphere. The entire life of the group was thus 103 days.

The scale of the accompanying photograph is one of 33 inches to the diameter of the sun.

Mr. J. W. Jarvis, F.G.S., St. Mark's College, Chelsea, S.W., has been appointed Class Secretary and Class Treasurer to the London Geological Field Class. The excursions this season are to Merstham on April 30, and to Purley, Henley, Wimbledon, Aylesford, Leighton, Bedford, Chislehurst on succeeding Saturdays.

NOTES

ASTRONOMICAL.

Comet 1904, *a* (Brooks).

After an interval of seven months, during which no comet has been under observation in the northern hemisphere, a new comet was discovered by Professor W. H. Brooks, Director of the Smith Observatory, Geneva, U.S.A. The new object, as the following elements by Herr E. Stromgren will show, has almost exactly the same perihelion distance as the comet discovered by M. Giacobini, December 2, 1902. Only one other comet is known with a perihelion distance greater than these, namely, that of 1729. An examination of the Harvard photographs taken before the discovery of Brooks' comet furnished six plates, showing objects which might possibly be identical with it. These were taken on March 11 and 15, and April 1, 5, 13, and 16. The first two places have not as yet been satisfactorily included in any orbit, and possibly the images shown on these two plates do not in reality belong to the comet. The nebulæ N.G.C. 6555 and 6564 are in the immediate neighbourhood of the place indicated by the plate of March 11. At the present time the comet is receding both from the earth and from the sun, and is slowly diminishing in brightness. This makes the twenty-fourth comet discovered by Professor Brooks.

Elements.

T = 1904, Feb. 28, 8130 M.T. Berlin

$$\left.\begin{aligned} \omega &= 50^\circ\ 51'\ 30'' \\ \Omega &= 275^\circ\ 17'\ 36'' \\ i &= 124^\circ\ 59'\ 38'' \end{aligned}\right\} 1904{\cdot}0$$

$\log q = 0{\cdot}42951$

* * *

Methods of Determining Jovian Longitudes.

In the "Monthly Notices" of the Royal Astronomical Society for March, 1904, Mr. Stanley Williams institutes a comparison between the method of determining the longitude of markings on Jupiter by estimating the times when they appear to be exactly in mid-transit with the method of measuring their distances from the two limbs of the planet by a micrometer; and he gives good reason for thinking that the first and simpler method is, in the hands of a practised observer, not at all inferior in accuracy to the latter. The micrometric method has been supposed the better from the comparison of measures of the same object made on the same night; obviously transits of any object can only be compared as taken on different nights. Mr. Williams has in this paper compared micrometric measures made of objects on different nights, and finds that they show no superiority in accuracy over the method of transits.

* * *

Change from Taurus to Aries as First Sign of the Zodiac.

The same number of the "Monthly Notices" contains a paper by Mr. and Mrs. Walter Maunder, in which they show that there are clear indications in Assyrian records of two distinct methods having been in use for the determination of the beginning of the year. The earlier was that of the heliacal setting of Capella. This involved the recognition of Taurus as the first constellation of the zodiac, and was no doubt in operation as early as 2000 B.C. The second was the direct determination of the equinox by some form of time-measurer. Other advances in connection with this seem to be indicated; the recognition of the ecliptic as distinct from the equator; of the ascending node; of the nature of the motions of some at least of the planets; and the division of the ecliptic was effected into twelve equal signs as distinct from the twelve irregular constellations. The date when these changes took place cannot have been very different from that when the star Hamal, the brightest of the constellation Aries, marked the spring colure, *i.e.*, about 700 B.C., and the remarkable outburst of scientific activity which is thus indicated was in all probability associated with the great literary activity of the reign of Assurbanipal.

* * *

The Astrographic Catalogue.

It is now seventeen years since the delegates of seventeen different nationalities met in Paris, under the presidentship of Admiral Mouchez, to consider the question of a photographic chart of the whole heavens, down to the stars of the fourteenth magnitude, with a catalogue of stars to the eleventh magnitude. The latter portion of the programme is now beginning to be realised; the Potsdam observatory has already produced three volumes of its catalogue; the observatories of Helsingfors, of Paris, and of the French colonies have also begun to publish; and the Astronomer-Royal, at the meeting of the Royal Astronomical Society, already alluded to, presented the first volume of the Greenwich catalogue, covering one half the Greenwich section. The introduction to the catalogue contains a number of exceedingly interesting discussions; of the effect of personality on the measurement of the places of stellar images, of the probable error of the measures, and of the determinations of photographic magnitudes. The accuracy of the measures of position are of the same order as of observations with the transit instrument; the probable error of the position of a star, in arc of a great circle, deduced from the measures on one plate is $\pm\ 0{\cdot}26''$ in R.A., and $\pm\ 0{\cdot}28''$ in Declination. In the investigation of photographic magnitudes, it was found that in passing from one exposure to another the law, exposure $\times$ brightness equals constant, held almost exactly, except in the case of the shortest exposures, which gave fainter stars than would be expected in accordance with the law.

* * *

Distribution of Stars of the Third and Fourth Type.

In a discussion of the distribution of the coloured stars, Herr Freidrich Kruger gives in the "Astronomische Nachrichten," No. 3947, a table dealing with 3800 stars of the third and fourth types of spectra. These are distributed into eight zones, each twenty degrees in breadth, the galactic equator running through the middle of the fifth zone. The table shows that about 4 per cent. of the stars of the third type of spectrum are known to be variable, but 14 per cent. of the fourth type. Both cluster towards the galactic equator, but that clustering is much more evident with the fourth type stars. These two relations were drawn attention to by Professor Hale in his recent "Memoir on Stars of the Fourth Type." A curious point of difference between the two types is shown by Herr Kruger's table, namely that whilst the numbers of the third type show but very small increase with diminution of magnitude, the faintest class of the fourth type includes more than all the other six classes combined.

* * *

The Spectroscope Binary, Iota Pegasi.

Professor W. W. Campbell discovered in 1899 that Iota Pegasi was a spectroscopic binary, and Mr. Heber D. Curtis, from a very thorough discussion of forty-three photographs of the spectrum extending over six years, has obtained very accurate final elements for it. The period found is 10·21312 days, and the velocity 47·12 kilometres. The orbit is nearly circular, the eccentricity being 0·0085, so that the epoch of periastron is not very certain. Dr. R. G. Aitken examined the star in 1901 with the 36-inch refractor of the Lick Observatory, but was not able to detect any evidence of duplicity.

The adaptation of the Forty-Inch Visual Refractor of the Yerkes Observatory to Photography.

In the original design of the forty-inch refractor of the Yerkes Observatory, no provision of any kind was made for direct photography; there is no guiding telescope to enable lengthened exposures to be given, nor photographic corrector to bring the actinic rays to a focus on the sensitive plate. Mr. G. T. Ritchey has overcome the first difficulty by means of an eyepiece magnifying about one thousand diameters, placed in the side of a double slide carrier. A small diagonal prism receives the light of the guiding star, and reflects it at right angles into the eyepiece, and this with its accessories are mounted on a slide which can be moved to any desired position on the upper side of the rectangular box, and firmly clamped there, so as to assist in finding a suitable guiding star. The star is brought to the intersection of the cross-lines in the eyepiece, and is kept there throughout the exposure of the sensitive plate. The observer sits with his eye at the guiding eyepiece and his fingers on the two screws which move the slides, and thus he introduces any minute corrections of position which he sees are necessary. These corrections may be on account of either the irregular movements of the driving clock of the telescope, or more frequently from the tremors in the atmosphere. The latter irregularity may require correction several hundred times in a minute, and a practised observer can introduce between one and two hundred per minute. The other difficulty that the instrument is a visual one Mr. Ritchey has obviated by the use of a delicately tinted yellow screen. This screen utilises the rays of light which are most freely transmitted by a large objective; since it is a well known fact that while only a small percentage of the yellow rays are lost by transmission through a large and necessarily thick objective, a very large percentage of the blue rays are. Consequently the forty-inch visual objective, thus used with a yellow screen, and plates sensitised to the yellow rays, is scarcely less rapid, if at all, in photographing stellar images, than an object-glass corrected for blue rays would be. In two hours it registers stars of approximately the seventeenth magnitude, which are at the visual limit of the instrument; and in five hours can register stars of a magnitude fainter. The yellow screen is formed from two thin and transparent plates, finely ground flat and highly polished. One of these plates, which are 8 by 10 inches, is flowed over with a collodion film of a delicate yellow tint, and when the film is dry, this is covered with Canada balsam, and the other plate bound on it as a cover glass by adhesive tape. When in use it is laid close upon the sensitive plate, nothing separating them but the tape. Mr. Ritchey has been most successful in photographing portions of the moon's surface, and close clusters of stars, and in Vol. VIII. of the Decennial Publications of the University of Chicago, several very fine specimens are given, notably one of the lunar crater Theophilus and its surroundings, which perhaps shows the detail on the moon's surface more clearly than any other photograph ever taken. In the photographs of the clusters Messier 13 and 15, the original negatives and transparencies from them show the star images separate and distinct, even at the very centre of the cluster, but in the process reproductions given in the volume the smaller and nearer stars are merged together. With nebulæ the yellow screen is not so successful since these are rich in their proportion of green rays, which do not come to the same focus as the yellow.

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Photographs with the Two-Foot Reflector of the Yerkes Observatory.

Seven very fine specimens of the work done with the two-foot reflector of the Yerkes Observatory are published in Vol. VIII. of the Decennial Publications of the University of Chicago. These are of the two giant nebulæ of Orion and Andromeda; of the spiral nebulæ Messier 33 Trianguli and Messier 51 Canum Venaticorum; of the carded wool like nebulosity in the Pleiades; and of the torch-like nebulæ in Cygnus known as N.G.C. 6960, and N.G.C. 6992. These two last form part of the same extended nebulosity, but they present some striking differences in their relationship to the stars. In the first case the nebula seems to act as a wall or barrier separating a region strewn very thickly with stars, from a sparser field; in the other case no such difference in the number of the stars seems to exist on the two sides of the nebula, which itself appears to lie in a district of few and small stars.

ZOOLOGICAL.

Mosquitoes in England.

Despite the coldness and wetness of the season, mosquitoes, according to the "Report on Economic Zoology," issued by the Trustees of the British Museum, appear to have been unusually numerous in England last summer, and to have caused much annoyance and inconvenience. They were very prevalent in parts of Essex, especially in the neighbourhood of Epping Forest, and also in Kent and Surrey, notably along the valleys of the Thames and the Kennet, and in the marshes bordering the lower courses of the Thames and the Lea. They were also reported as having caused much annoyance near Bristol, at Great Staughton, Huntingdonshire, and at Weston-super-Mare, Worplesdon, Colchester, Canterbury, and Birchington. Although complaints of mosquito bite are received almost yearly from the Thames Valley, last summer the insects in question seem to have been unusually virulent, causing such swellings that medical attendance was in some instances requisitioned. The species most abundant were the common gnat (*Culex pipiens*) and the banded gnat (*Theobaldia annulata*), the latter of which does not usually attack man. This reminds us that we fail to see the reason for dropping the good old English word "gnat" in favour of the foreign "mosquito," now that both are known to be the same.

* * *

A Deer-like Antelope.

Hitherto there has been supposed to exist a sharp distinction between deer and antelopes, according to the nature of their horns; but recent discoveries in North America tend to show that this distinction is only a feature of the present day. Deer, it is almost superfluous to mention, have deciduous bony antlers, while in antelopes the horns are covered with hollow sheaths, which are never shed and never branched. The American pronghuck resembles antelopes in its skeleton, but its horns are forked. The new fossil type combines the skeleton and teeth of an antelope with the antlers of a deer.

* * *

New British Mouse.

According to a note by Mr. W. E. Clarke in the Proceedings of the Royal Physical Society of Edinburgh, the mouse of the Faroe Islands is a large and stouter built animal than the common house mouse, from which it also differs in colour. It is therefore regarded as representing a distinct local race of that species. St. Kilda has also a peculiar mouse of its own.

* * *

A Rare Bird at the Zoo.

The Zoological Society's menagerie in the Regent's Park has recently received an interesting and valuable addition in the form of a specimen of the South American boat-billed stork (*Cancliroma cochlearia*). It is many years since this species, which, by the way, must not be confounded with the shoe-bill of the White Nile, has been represented in the collection.

* * *

New Egyptian Fossils.

Great interest attaches to the description by Dr. Fraas, of Stuttgart, of certain very remarkable fossil mammalian remains from Lower Tertiary marine strata in the Mokattam range, near Cairo. These specimens serve to show that a gigantic Tertiary whale-like creature, known as *Zeuglodon* (of which the remains were first discovered in North America), is the direct descendant of the primitive land Carnivora of

the early Tertiary, the newly-discovered form being actually the missing links. Hitherto, *Zeuglodon* has been generally regarded as an ancestral type of whale, but this, according to Dr. Fraas, is incorrect; that creature, although marine, having no sort of affinity with the Cetacea. If this be so, we have still other missing links to discover, namely, the progenitors of the latter group.

* * *

Fish Scales.

We may now, it seems, ascertain the age of the cod and haddock sent to us by our fishmonger by the examination of their scales. For it appears, according to recent researches, that the scales of these fishes, like those of carp, develop at intervals certain well-marked rings, which appear to indicate the limits of the annual growths.

* * *

An American Hedgehog.

The discovery in the middle, or Oligocene, Tertiary deposits of Dacota of the remains of an extinct species of hedgehog may not appear to non-zoological readers a matter of much importance. In reality it is a fact of the very greatest interest, for hitherto the hedgehog tribe (*Erinaceidae*) has been regarded as an exclusively Old World group. The discovery of the fossil American species (which has been made the type of a new genus, under the name of *Protheryx*, and is described in the sixth volume of the *Bulletin* of the American Museum) serves to strengthen the view of those who maintain that the northern countries of both the Western and Eastern Hemispheres form but a single zoological region; and that formerly there was comparatively free communication between them in the neighbourhood of Behring Sea, under climatic conditions which permitted of temperate forms passing from one continent to the other. When we know more of the Tertiary fauna of Eastern Siberia, it is probable that the number of groups of animals confined to one or the other hemisphere will be still further diminished.

* * *

Fish Destruction by Birds.

At a recent meeting of the Belfast Natural History and Philosophical Society, Mr. J. Brown gave reasons for concluding that there are 2,000,000 gulls in the United Kingdom, and that during the herring season each bird destroyed 200 fry per day, or 12,000 during the two months of the season. These, if they had come to maturity, would have been worth £24,000,000. He, therefore advocated the destruction of the gulls, each of which cost the nation £12 in two months in consequence of their protection by Act of Parliament. If we add to the damage done to herrings by gulls the loss inflicted on these and other fishes by cormorants, shags, gannets, guillemots, &c., there can be no doubt that the supply of food fishes is enormously diminished; and it seems little short of folly to be spending vast sums of money on the maintenance of fish-hatcheries at Piel and other places, and at the same time to do all we can to ensure the destruction of valuable fishes by encouraging the increase of their natural enemies. Birds, are, no doubt, charming adjuncts to scenery both on the coast and inland but such ornaments may be bought too dearly.

* * *

The Destruction of Whales.

In the course of a very interesting paper on whales and whaling contributed to the April number of the *Annals of Scottish Natural History*, Mr. T. Southwell tells us that whereas between the years 1814 and 1824 no less than 12,007 Greenland whales were killed off Greenland and in Davis Straits by British vessels, only 127 were accounted for in the ten years ending with 1902. Comment is superfluous.

* * *

Papers Read.

At the meeting of the Zoological Society, held on April 19th, Mr. O. Thomas exhibited the skull and skin of a hartebeest from Uganda, which were regarded as representing a new species; and also skulls of the North Australian rock wallaby, a species remarkable for developing an unusually large series of molar teeth, which are continuously shed and renewed. The same gentleman, in collaboration with Mr. Schwann, read a paper on twenty-one species of mammals collected during the work of the Boundary Commission between British and German East Africa, of which three were regarded as new to science. Mr. Beddard contributed the second instalment of a series of papers on the anatomy of lizards, dealing in this instance with the South American teguixin; Mr. Boulenger gave additional information with regard to the skeleton of the extinct Scots reptile *Telerpeton*; while Dr. Broom described the structure and mode of articulation with the skull of the lower jaw of some of the extinct mammal-like reptiles of South Africa. Finally, Mr. Druce gave descriptions of three and twenty new South American butterflies. At the meeting of the same body on May 3rd the following four papers were read, namely: Mr. Thomas on the osteology and systematic position of the Malagasy bat *Myzopoda aurita*; Mr. Beddard on certain features in the vascular system of chameleons and other lizards; Mr. A. D. Imms on the gill-rakers of the sturgeons of the genus *Polyodon*; and Dr. Ridewood on the skulls of certain bony fishes. A sketch was exhibited of a young African elephant remarkable for the amount of hair on its body; and a photograph was shown of the last Quagga living in the menagerie. At the Geological Society on April 27th, a new species of fossil scorpion from the coal measures of Lancashire was described by Messrs. Baldwin and Sutcliffe.

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Mr. W. Royal Dawson writes: With reference to the Note in last month's "KNOWLEDGE" (p. 96) on the prior opening of the right eye, I may state that out of a litter of eight tame white rats born a short time ago no less than seven opened the right eye first, while the eighth showed no tendency to do so. I think this will suffice to confirm the supposition that the right eye is the first to be opened in the order *Rodentia*.

BOTANICAL.

AN abstract of Mr. G. Massee's interesting paper "On the Origin of Parasitism in Fungi," which has recently been published in full in the *Philosophical Transactions* of the Royal Society, is given in the Society's *Proceedings*, and also in the *Annals of Botany* for April. The author explains why it is that a certain parasitic fungus is often only capable of infecting one particular species of plant. Though the spores of these fungi germinate freely on the surface of any plant when moist, infection is confined to the particular species of plant which is the usual host of the parasite. This selective power is attributed to chemotaxis. The presence of saccharose in the cell sap of the host plant is found to induce infection by many saprophytic and parasitic fungi, unless the influence of this attractive or positively chemotactic substance is overcome by the presence of a more powerful negatively chemotactic or repellent substance. Apples, though containing saccharose, are immune from the attacks of *Botrytis cinerea*, which preys on a greater number of different plants than any other known parasitic species. This immunity is due to the presence of malic acid, which is repellent or negatively chemotactic to the germ tubes of this particular fungus. Experiments have shown that a fungus can be induced to attack the leaves of a plant, on which it is not ordinarily parasitic, by injecting into them the substance which is known to be positively chemotactic to its germ tubes.

In the *Annals of Botany* for April, Mr. J. Parkin calls attention to the nectaries on the bud-scales of the Para Rubber tree, *Hevea brasiliensis*, apparently the only plant that possesses them on these organs. The Euphorbiaceae, to which *Hevea* belongs, contain numerous species in which extra-floral nectaries are present, usually on the stem or on the lamina or petiole of the leaf. *Hevea* also has them on the leaves, and various references to these have been made by writers, but the nectaries on the bud-scales seemed to have been overlooked altogether. This is probably due, as the author

explains, to the fact that an adult tree of the *Hevea* "puts forth fresh foliage annually, and the bud-scales being caducous, are merely evident while the shoots are in the immature condition." The honey secreted by the nectaries encourages the visits of ants, whose presence assists in safeguarding the developing foliage from the attacks of injurious insects.

PHYSICAL.

The Emanation from Radium Bromide.

To show the diffusion of the emanation from radium bromide, Mr. T. Indrieson, in a paper recently read before the Russian Physico-Chemical Society, used a long tube, the internal surface of which was coated with a layer of zinc-sulphide. On connecting the apparatus with a test-tube containing a solution of radium bromide, luminescence was found to appear and to be propagated throughout the tube. On repeating Ramsay's experiments, the author found that the yellow helium line did not coincide with the yellow lines of the spectrum given by the emanation, but was situated between the two yellow lines of the emanation. When the serpentine coil communicating with the tube was dipped into liquid air, a strengthening of the lines corresponding to the helium line was noted in the spectrum of the emanation, while between the two yellow lines above referred to a third line, coinciding with the yellow line of helium, appeared. The lines of helium do not exist in the spectrum given by the emanation of a freshly-prepared tube, but only appear afterwards. On observing the gases set free on the dissolution of radium bromide, it was observed that the helium lines did not appear as long as the spectrum tube preserved its phosphorescence in the dark. After four days this phosphorescence would disappear, and the lines of helium could be noted in the spectrum.—A. G.

* * *

Action of Radium on Metals.

In order to investigate the action of radium on metals, N. Orloff, as pointed out in a paper recently read before the Russian Physico-Chemical Society, covered, in April, 1903, an ebonite capsule containing 0·03 gm. of radium bromide with an aluminium plate 0·01 mm. thick, instead of the mica generally used. In the course of July the author, on opening the capsule, noted on the surface of the aluminium turned towards the radium some protuberances of the same aspect as the surrounding surface of the aluminium, and resembling small drops of melted metal. These protuberances proved to be radio-active, producing a photographic image on acting for some minutes through black paper; and even after six months they were found to emit invisible radiation without any appreciable weakening. The author thinks that a stable alloy is formed by the accumulation of material particles given off from the atomic systems of radium, around small aluminium nuclei.—A. G.

* * *

On Radio-Active Emanation from Water and Oil Fountains.

In a paper published in No. 8 of the *Physikalische Zeitschrift* (April 15, 1904), Prof. F. Himstedt arrives at the conclusion that radio-active bodies giving off a gaseous emanation are widely diffused throughout the earth; these emanations are absorbed by water or by petroleum, and after having been conveyed along with the latter to the surface of the earth, will thence diffuse into the air. Because of the many analogies noted between these emanations and radium emanations, the author thinks it possible that both are identical. In this case the ores of uranium, from which radium emanations are derived, would either be widely diffused or else there would be some further matters possessing, though to a lesser degree, the property of giving off emanations. Considering that the absorption coefficient of water, as well as of petroleum, with respect to this emanation, is found to decrease for increasing temperatures, while hot fountains, on the other hand, show an especially high activity, the hypothesis is suggested that the amount of radio-active mineral increases with increasing depth. The radio-active components of the earth should, therefore, possibly be allowed for in estimating the temperature of the earth's mass.—A. G.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Gloss yIbis in the Orkneys.

THE "*Annals of Scottish Natural History*" for May contains an account of a Glossy Ibis, *Ibis falcinellus*, shot a mile west of Stromness on September 19 last. According to Mr. Eagle Clarke this is only the second occurrence of this bird in the British Islands, the first having been shot in 1857 near Kirkwall. Some mistake has certainly been made here: for which Mr. Eagle Clarke can hardly be responsible. So good an ornithologist doubtless knows that at least thirteen instances of its occurrence in Great Britain are recorded, one of these being from Aberdeenshire—October 4, 1880. According to Mr. Ussher there are no less than twenty-two instances of its occurrence in Ireland.

* * *

Rough-Legged Buzzard in Co. Down.

The Rough-legged Buzzard, *Buteo lagopus*, is only a rare visitor to Ireland. According to the *Irish Naturalist* (May) a specimen was shot in November last in Co. Down—the fifth in Down. This appears to be the tenth recorded instance of its occurrence in Irish territory.

* * *

Stone-Curlew: Co. Donegal.

An example of this rare visitor to Ireland was obtained on October 12 last in Co. Donegal. This is the first time of its occurrence in Donegal. Only ten other cases of its occurrence in Ireland are on record, and eight of these, it is interesting to note, were obtained on the East Coast.

* * *

Ravens Nesting in Captivity.

Instances of ravens breeding in captivity are rare; and cases of successful rearing are still more so. Mr. W. H. St. Quintin's note in the *Field* (May 7) to the effect that he has in his aviary a pair of young that are nearly ready to leave the nest is therefore of considerable interest, especially so having regard to a certain police court prosecution which took place some time ago.

* * *

Great Crested Grebes at Richmond.

Mr. Gordon Dalgliesh sends us some interesting notes on a pair of these birds which he has had under observation since April 17 last. They have taken up their quarters in the Penn Ponds and appear to be breeding. When preening the breast feathers, he remarks, these birds turn over on to their backs and do not perform this operation when sitting upright as one would imagine. "The female, when she landed, did not stand upright, but dragged herself along on her belly."

* * *

Colour, and Coloration in Birds.

An extremely interesting and important paper on this subject was read by Mr. T. Lewis Bonhote at the Linnean Society on May 5, to which we hope to be able to refer later. Briefly, he contends that both colour and coloration are primarily due to physiological causes, and that the varied patterns and tints of plumage which distinguish different species are determined by the action of natural selection on these "expression points" of "vigour."

There is an intimate connection, he contends, between the bleaching process which takes place previous to moulting, and the development of conspicuously marked areas. These indeed, he holds, are nothing more than permanently fixed bleaching, or intensification areas, which he terms "pœcilomeres."

Messrs. Newton and Co., who have held appointments to the Royal Family continuously since 1800, have this week been honoured by a Warrant of Appointment as Scientific Instrument Makers to H.R.H. the Prince of Wales.

Bacteria and Radio-Activity.

By the kindness of Dr. Alan Green we are able to reproduce two photographs showing the effects that bacteria which have been submitted to the action of radium bromide, produce

Tuberculosis Bacilli.

on photographic plates. Small masses of bacterial growth were exposed to the β and γ rays of 10 milligrammes of virtually pure radium bromide. In a large number of instances such masses when removed from the influence of the radium and placed between two thin sheets of glass, themselves not radio-active, were capable of so affecting the sensitised film of a photographic plate with which they were brought in contact that, on development in the ordinary way, the plate showed a dark area corresponding to the shape of the bacterial mass. The photo-actinic rays proceeding from the bacteria which had been exposed to radium were capable of affecting a photographic plate through a double layer of lead foil. The rays thus emitted seem to coincide with the β rays of radium, for they are stopped by a sufficient thickness of lead. If any γ rays are emitted by the bacteria they do not appear to affect the photographic plate. It will be remembered that some years ago Dr. Johnstone Stoney remarked that the microscopic dimensions of bacteria might be due to the necessity of deriving their energy from the slower moving molecules of substances with which they were in contact, and more lately it has been suggested that the energy of radium might be due to the analogous power of that element to derive its energy from outside sources by sifting out the molecules of different speeds impinging on it. This theory, now received with less unanimity than the Rutherford-Ramsay-Soddy theory of the disintegration of the atom, is neither confirmed nor disproved by Dr. Alan Green's experiments, which appear to show that bacteria, so far as acquired radio activity is concerned, behave like other substances. One of our photographs shows the blur made by a mass of tubercle bacilli on a plate; the other the effect similarly produced by anthrax spores. The acquired radio-activity lasts in some instances for over six weeks.

Spores of Anthrax.

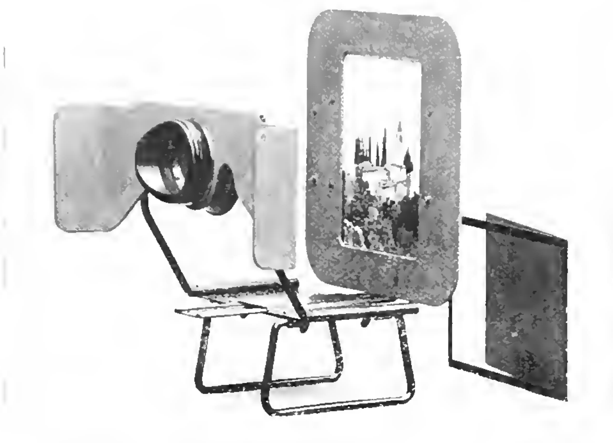
A Stereoscopic Single Lens.

A new method of obtaining stereoscopic photographs, and stereoscopic effects when looking at them, has been designed by Dr. M. Von Rohr, of the Carl Zeiss firm. Its peculiarity is that the effects are obtained by a single lens directed at single

Viewing through the Single Lens Stereoscope.

photographs. The photographs are taken with objectives of a focal length below that of the range of distinct vision, which in normal sighted people is about ten-and-a-quarter inches. Such a photograph viewed in the ordinary way would appear to be out of perspective and its parts out of proportion, though some of this impression could be to some extent removed or remedied by magnifying the photograph.

The accompanying figure indicates a method by which the



Single Lens Stereoscope, with Photographs.

eye can obtain a virtual distance-image magnified of the photographs. The apparatus will, in the case of normal vision, bring the different parts of the photograph under the same visual angles as those obtaining at the moment of photographic exposure. An achromatic magnifying lens is used, the focal distance of which is similar to that of the objective used in photographing the object, and which is free from distortion for objects situated at $1\frac{1}{16}$ inches from the nearest lens

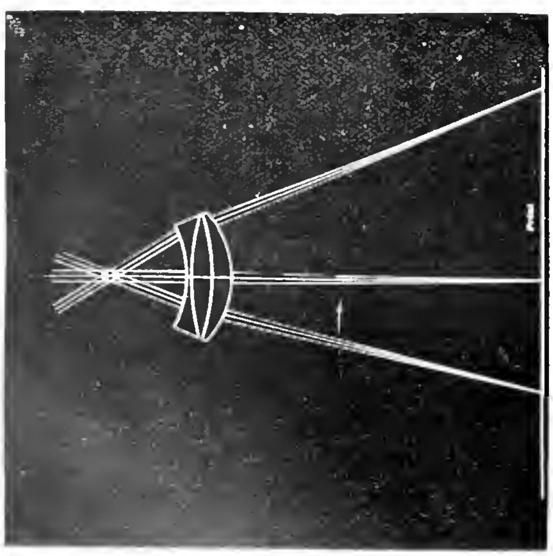


Fig. 3 (Single Lens Stereoscopy).

surface. The lens (fig. 3) is free from astigmation but not from curvature of field. Therefore when using it the accommodation of the eye must be altered according as the central part or the marginal part of the photographic print is under inspection; and the nature of the eye accommodation will vary for short-sighted, long-sighted, and old-sighted people. But if all the directions are carefully followed, an eye of normal vision will perceive through the lens, not the photograph as it appears to the unaided eye, but a far distant image of it, free from distortion, and under the same conditions of apparent size, distinctness, perspective, light and shade as those under which the objects themselves would be seen with the short photographic objective that has been mentioned. Consequently the small photograph thus conveys to the eye a much more natural effect than a landscape photograph can possibly do; and unconsciously the vision forms in the mind a correct perception of relief and distances. Thus although the stereoscopic effect is not of the same kind as that produced in ordinary stereoscopes, the effect of solidity is strongly evident and perceptible.

A.G.

"Osprey" Plumes, Real and "Artificial."

By W. P. PYCRAFT, A.L.S., F.Z.S., &c.

WITHOUT doubt the most beautiful of feather ornaments is that commonly known as the "Osprey" plume. How this name came to be used is a mystery, for the feathers in question are not obtained from the Osprey, which is a bird of prey, but from various species of Herons, those known as "Egrets" furnishing the most highly prized varieties. It is from the French form of this word Egret, that the term "aigrettes," often used instead of "Osprey," is derived. Naturally, the possibilities of these plumes as head-dresses, both for men and women, have been widely appreciated. Only in the Army, however, have they been worn by men in this country, and the practice has now been happily abolished. To induce our countrywomen to follow this lead, the most strenuous efforts have been made within recent years to spread a knowledge of the consequences which follow from the encouragement of the traffic created by their demands. Though at last there seems some prospect of success attending these efforts, unless progress towards this end is more rapid, the extermination of the hapless victims is inevitable. This in itself would be an end much to be deplored, but the nameless suffering and pain, which accompanies this extinction, makes the "passing of the Egret" a pitifully sad story.

To many women the broad outlines at least of this matter are already well known, and, as a result, numbers have decided to leave such ornaments severely alone. Others, unable to break the spell wielded by these seductive plumes, have compromised, by forswearing what they believe to be real "Ospreys," and wearing, instead, what they fondly imagine to be an artificial product.

In purchasing "Ospreys," at least in most milliner's shops, whenever scruples are manifested, the assistant professes to have doubts about the genuineness of the plume, retires to the Manager, and returns, assuring the anxious customer that a mistake has been made, that, after all, the plume is artificial. This fact, long known to the authorities at the British Museum, was shamelessly admitted, only a few days ago, by the Manager of a large shop in London. "But ladies," he remarked, "are hard to please. . . . Their consciences have to be soothed, and the assistant, rather than lose valuable custom, readily sells the article as artificial!"

In the wholesale trade the word artificial appears to have been used in a technical sense, long before the agitation against the wearing of "Ospreys" began. Inferior "Osprey" plumes and feathers of birds other than Egrets or their allies, which have been disguised to simulate "Ospreys," are known by the wholesale buyers as "*artificials*."

But let it be distinctly understood that the assertion of the retail milliners, that the plumes sold by them as artificial are made of quills split up, or of whalebone, or of any other material, are *absolutely false*.

The broad facts concerning "Osprey" or "aigrette" plumes and their origin are briefly these. The "aigrettes" of the milliner are the long, loose, waving plumes taken from the backs of different species of small Herons, the white plumaged species, some ten in number, being the most valued. The finest kinds are those from the Little Egret, *Garzetta garzetta*, and the Black-footed Egret, *Garzetta nigripes*. In both species the plumage is pure white, and the long "train" feathers are of a peculiarly loose, flowing type, of great delicacy, and recurved at the tip. It is this latter peculiarity that gives them the peculiar value. The little Egret occurs in Southern Europe, China, and Japan, S. Burma, India, Ceylon, Malay Archipelago, and Africa.

Fig. 1.—Three plumes of a white Egret, *Garzetta garzetta*, used for the purpose of making "ospreys" or "aigrettes." Note the extreme length and slenderness of the "barbs" or thread-like branches of the feather.

The black-footed species has a more restricted distribution, being found only in Java, the Moluccas, and Australia.

A third species, *Leucophoyx candidissima*, also produces recurved plumes, but these are not so fine as in the two just enumerated. This bird occurs in temperate and tropical America.

In all the species on which this war is waged, some 16 or 17 in number, these feathers are of great length. In some—*e.g.*, *Mesophoyx intermedius*—they may attain a length of 17 inches. From a bundle of such, as many as four separate plumes could be cut. The delicate terminal portions of the feathers furnish the "genuine Osprey" of the wholesale trade, and fetch a high price; whilst the three lower segments are sold as "artificials" often at a ridiculously low price—so low that it has often been contended that they could not on that account be real feathers. But the tips pay for the whole bundle and leave a profit; the lower portions of the feather, therefore, may well be sold cheap.

Besides the white Herons—some ten species in all—there are several others laid under contribution. These birds are of varied colours, and the plumes are sold as "red" or "ash" Ospreys, and so on, as the case may be.

But "artificials" are manufactured, in a sense, by manipulating the feathers of birds other than Herons, so as to produce what is at best a crude resemblance to the real plume. Probably the majority of these are made of what are known in the trade as "Vultures'" feathers, which are really the quill or "flight" feathers of the Rhea or South American Ostrich. The method of preparing them is interesting. The shaft of the quill is split down the centre, so that one half of the "vane" of the feather adheres to each half of the stem (fig. 3). By spirally twisting this stem (fig. 4), the barbs forming the right or left side of the "vane" of the feather are made to form a series of long, slender filaments spirally arranged around a central shaft. The effect produced, though graceful, is really quite different to that of *the* "Osprey" (fig. 1). Moreover, the whole plume is heavier in appearance. Feathers so treated are sold as artificial, and there is enough truth in the statement to be really

Fig. 2.—An osprey plume as sold at the milliners. In this case the plume has been dyed black. It is made up of two portions—a few valuable tips stuck into a bunch of stumps—*i.e.*, "Egret" plumes, from which the tips have been removed.

dangerous—dangerous inasmuch as whether sold as artificial "Ospreys" or as "Vultures'" plumes, the slaughter of Rheas is encouraged. Indeed, the extinction of this bird, in a wild state, seems to be rapidly approaching. Annually slain by thousands for the sake of its feathers, this Rhea has already been extirpated from much of country it formerly inhabited. That this should be so is deplorable, for the Rhea is a bird of the utmost scientific interest and importance.

An equally crude imitation of the real "Osprey" is made by treating Peacocks' feathers in the same way as that just described in the case of the Rhea.

But obviously the stump ends of real Egret feathers, or the split and spirally twisted feathers of the Rhea and Peacock, *cannot be called artificial* feathers. But what is one to do? some of my readers may ask. How can the Egret feathers be distinguished from those of the Rhea or Peacock? Do not try. Firstly, this is the work of an expert; secondly, the sale of the imitation "Osprey" does but encourage the slaughter of another species. If the Egret is spared, the Rhea must die.

It should be made a punishable offence to sell feathers under the designation of "artificial," for thereby incalculable harm is done, and women are again and again made parties to a traffic they abhor. True, some do not care; but many do. To sell feathers of any kind as artificial is to obtain money by fraud. A man can no more be justified for selling as artificial that which is real, than for selling chalk and water as milk.

To give an idea of the appalling waste of life which the trade in "Ospreys" is responsible for, we may remark that in London alone, last year, the produce of 196,000 birds was sold! As many were probably sold in the markets of Paris and Berlin, since London no longer has the monopoly of the feather trade.

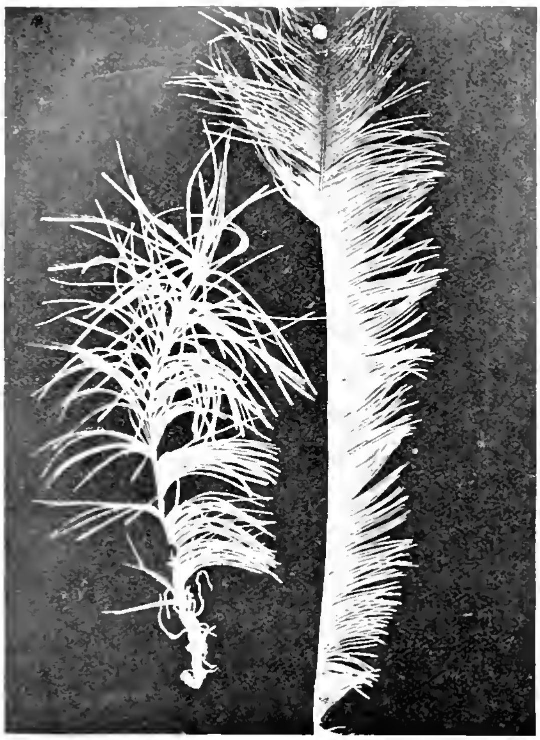


Fig. 3.—Portion of a quill feather of a Rhea. From the left side a large piece of the stem has been cut. By twisting this round, the barbs become isolated and simulate, crudely, the "osprey" plume. Such plumes are sold in the shops as "imitation ospreys," or as "vultures'" feathers.

Unfortunately for the Egrets, these feathers are worn only during the breeding season, and by both sexes. As a consequence the slaughter of the adult birds at this time ensures the death by slow starvation of thousands of young. Really the prosecution of such butchery is devilish; but what shall be said of those who, knowing this, yet purchase these ghastly trophies? To write temperately on this aspect of the subject is difficult. The accounts published by Mr. W. E. D. Scott, an American ornithologist of the highest standing, are positively sickening. Yet he purposely refrained from making anything but the baldest statements of fact; so much so, that those who do not know him, as the writer does, might accuse him of callousness. In his investigations, made in 1886, into the condition of some of the Bird Rookeries of the Gulf Coast of Florida, he found that since his last visit, six years previously, whole colonies of birds, numbering in their palmy days many thousands of individuals, had been absolutely wiped out by "plume-hunters." These ghouls travelled in bands of sometimes as many as 60 in a band. Let me quote two or three passages from his paper as a sample. Visiting the breeding place of the reddish Egret in Charlotte Harbour, he writes: "This had evidently been only a short time before a large rookery. The trees were full of nests, some of which still contained eggs, and hundreds of broken eggs strewed the ground everywhere. . . . I found a huge pile of dead, half-decayed birds lying on the ground, which had apparently been killed for a day or two. All of them had the 'plumes' taken with a patch of skin from the back, and some had the wings cut off. . . ." Again: ". . . the extermination of a Brown Pelican Rookery . . . is a very fair example of the atrocities that have been and are still being committed to obtain 'bird plumes.' . . . One afternoon, when Johnson (his informant) was absent from home, hunting, the old Frenchman (A. Lechevallier) came in with a boat and deliberately killed off the old birds as they were feeding their young, obtaining about one hundred and eighty of them. The young, about three weeks old, to the number of several hundred at least, and utterly unable to care for themselves in any way, were simply left to starve to death in their nests, or eaten by raccoons and buzzards."

One feels sorely tempted to add to this catalogue of crime if only in the hope that it may stir up some compunction in the minds of those directly concerned. Nowadays, unfortunately, we have become saturated with a spirit of scepticism, which is nowhere more injurious than in questions of this kind. "But is it not all horribly exaggerated? It really can't be true, you know!" is the cry of some to whom I have related these horrors. Others shrug the shoulders and say: "We really must not be sentimental; let us set to work, quite dispassionately, and collect evidence." And there they leave the matter!

Statements have appeared from time to time to the effect that Egret farms, on the lines of Ostrich farms, have been started both in Tunis and in America. The American farm was visited some time since, and found to consist of half-a-dozen birds in a small cage in a back yard. A detailed and glowing description was published in a German paper in 1896 of the success which had attended the establishment in Tunis. But the statement that the birds were fed on the carcases of horses, mules, and donkeys, aroused one's suspicions, and these are confirmed by the assurance that the birds are deplumed *twice* a year. The long plumes, as a matter of fact, are worn *only* during the breeding season, and therefore the story of the double crop proves too much. After careful enquiry, I cannot find that there is a shadow of truth in any part of the story. But it has caused much mischief, since plumes have been sold as the product of such farms.

Buyers of these feathers in milliners' shops are often told that the feathers are not plucked from the bird at all, but picked up off the ground. It is probably true that here and there a moulted feather is picked up in fair condition, but these can always be recognised by their soiled state and brittleness. They are useless for decorative purposes. Though normally white, these plumes, it should be remarked, are often dyed, but that does not make them "artificial."

From the illustrations to this paper there can be little difficulty, really, in distinguishing the "Osprey" plume, taken from the Egret, from the imitation "Osprey" made of Rhea feathers, or from the feathers of the Peacock. Undoubtedly, and unfortunately, the Egret plumes are the more graceful. Were this not so, one might hope to persuade those who consider feather ornaments of this kind necessary, to adopt the wearing of Rhea feathers, if

it can be shown that these birds can be farmed at a profit, as in the case of the Ostrich. So far, however, all endeavours to start a new industry of this kind appear to have ended in failure.

It is to be hoped that even imitation "Ospreys" will be eschewed in future, until some substitute for real feathers can be found which will possess the airy grace of the genuine "Osprey," or until they are made of feathers taken from birds bred for this purpose, or from some domesticated species. As it is, the good resolution

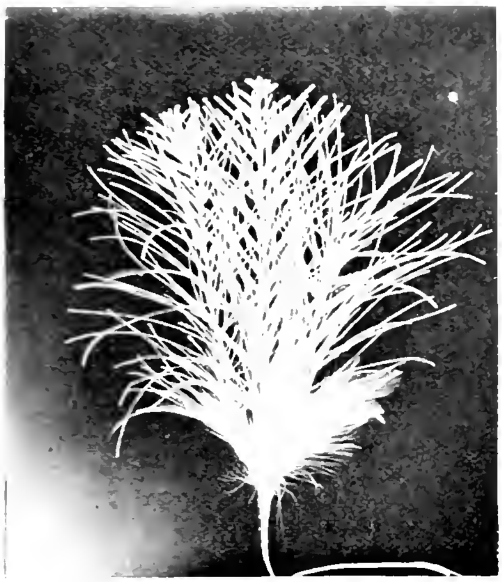


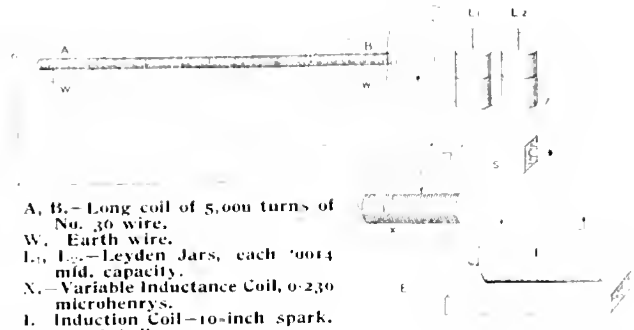
Fig. 4.—An "imitation osprey" as sold in milliner's shop; said to be made of vultures feathers. It is really made by splitting and twisting feathers of the Rhea, or South American Ostrich.

to wear only imitation "Ospreys" would create as much mischief as the wearing of the genuine plume, since the species called upon to furnish the "imitation" would themselves sooner or later suffer extermination.

Finally, "Imitation Ospreys" are simply made by using the feathers of other birds, and up to the present time these have been of wild birds. The statements that imitation or artificial Ospreys are made of split quills, whalebone, or other material, are all *absolutely false*.

Electric Wave Measurement.

Dr. J. A. Fleming, F.R.S., exhibited at the Royal Society Soirée a very ingenious and interesting device for the measurement of electric wave lengths. The principle of the method will be grasped by anyone who has watched sea waves impinging against and rebounding from a sea wall. The returning waves sometimes reinforce and sometimes neutralise the oncoming ones, so that here we have a wave crest raised above its fellows, and there a wave neutralised or eliminated. If the waves were all quite regular, and were uniformly propelled and reflected, these points of reinforced and eliminated waves would be fixed. We should in short have "nodes" and "loops" of force in the train of waves. Dr. Fleming's apparatus for showing the nodes and loops of an electric train of waves consisted of a spiral of fine wire, along which the discharge of two Leyden jars propelled vibrations varying in number between a quarter of a million a second. The resultant electric wave travelled along the spiral at about fifteen hundred miles a second, was reflected and returned, thus establishing on the wire stationary electric waves, just as stationary aerial waves are produced in an organ pipe. The position of the nodes and loops was ascertained by use of a series of carbonic dioxide vacuum



A, B.—Long coil of 5,000 turns of No. 30 wire.
W. Earth wire.
L1, L2.—Leyden Jars, each ·0014 mfd. capacity.
X.—Variable Inductance Coil, 0-230 microhenrys.
I. Induction Coil—10-inch spark.
S.—Spark balls.

tubes, which glowed when near a loop—the point where the oncoming and returning waves joined to produce a region of maximum electric force. Some further details of the apparatus are as follows:—

The long solenoid of silk covered wire has 5000 turns and a total length of 643 metres. This solenoid has parallel to it an adjustable earth wire and a divided scale. The solenoid is connected to one point on an oscillatory electric circuit consisting of a couple of Leydens having a capacity of 0·00068 mfd. and an adjustable inductance of 0 to 230 microhenrys and a silent discharger. When oscillations are set up in this circuit by induction coil discharges, and the frequency adjusted, stationary electric waves are set up in the solenoid.

The position of the first node is always well defined. Theory indicates that the distance from the end of the solenoid to the first node should be to the distance between the first and second nodes in the ratio of 1 : 2·5, and that the distance between the first and second nodes should be half a wave length. Experiments with this apparatus give a mean value of 1 : 2·4 for the above ratio for the first five odd harmonics.

The inductance of the long spiral is 100 microhenrys per centimetre of length and its capacity is 26×10^{-6} of a microfarad per centimetre of length. From these data the velocity of the wave along the spiral is found to be about 196 million centimetres per second.* From the wave lengths experimentally determined the corresponding frequencies are then found, and these agree substantially with the frequencies as calculated from the inductance and capacity of the Leyden jar circuit that is employed. Thus, corresponding to the first odd harmonic the node is 64 centimetres from the end. The inductance in the jar circuit is then 79 microhenrys, and the frequency as determined from the node-position and wave-velocity is 720,000 complete oscillations per second; whilst from the jar circuit inductance and capacity it is 690,000, or in fair agreement. The practical interest of the apparatus lies in the fact that it is in actual use for measuring the lengths of wireless electric waves such as are sent out from the station at Poldhu, in Cornwall.

$$* \text{ Frequency} = \frac{5 \times 10^6}{\sqrt{\text{Capacity of Jar in microfarads} \times \text{Induction of Coil in c.m s.}}}$$

See Dr. Fleming's Cantor Lectures, 1900.

The International Association of Academies.

The chronicle of scientific movements of the past month would be incomplete without a record of the meeting in London of the General Assembly of the International Association of Academies, an event which brought together a singularly noteworthy gathering of men of science and of letters. An assemblage of such cosmopolitan and select character as this was, comprising the representatives of the premier academies of the world in the departments of knowledge, had not hitherto been seen in the metropolis. We have been privileged to receive and welcome from time to time the various foreign deputies to the peripatetic meetings of the British Association, as well as those attending the meetings of chemical, medical, and allied learned bodies, but never a congress of the world's academies. This necessarily stands on a plane distinct from composite gatherings held under auspices such as the above mentioned, responsible though they be in themselves, and worthy of all respect.

The reason lies upon the surface, and is easy to state. An amalgamation of academies strikes a new note, for it is based on the wider authority that may be derived from international co-operation, regularly organised, and made applicable to the advancement of learning in its broadest aspects. Here is an effort to open up useful avenues of knowledge, and break untrodden ground under the stimulating influence of a common purpose. And what of the need for an organisation possessing these aims and characteristics? The answer is that its inception is the actual and perceptible response to aspirations long entertained by men of science and learning of various countries. It may be recalled that Sir Michael Foster, at the Dover meeting of the British Association in 18[illegible], uttered these weighty words:—"No feature of scientific inquiry is more marked than the dependence of each step forward on other steps which have been made before. The man of science cannot sit by himself in his own cave weaving out results by his own efforts, unaided by others, heedless of what others have done and are doing. He is but a bit of a great system, a joint in a great machine, and he can only work aright when he is in touch with his fellow-workers."

From general considerations of this nature, reference may pass to the initial steps that led ultimately to the foundation of what is now denominated the Association of Academies. Germany, the home of the greatest of all academicians, Leibnitz, had zealously fostered for many years a union of the Royal Societies of Gottingen and Leipsic, in collaboration with the academies of Vienna and Munich, called a "cartell." This met annually, turn by turn, at convenient centres for the purpose of discussing matters of science and learning in which a partnership of effort was beneficial for the several ends in view. It so happened that the scheme of the Royal Society of London (now in active operation) for the promotion of a universal and continued catalogue of scientific literature on an international basis was one of the subjects submitted to the cartell at its meeting at Göttingen in the year 18[illegible], at which, it should be mentioned, English representatives were present by special invitation. The latter, however, at the time, had been coupled with the expression of a wish that the Royal Society would consider the question of itself joining the cartell. To this cordial and significant desire for an extension of the boundaries of the cartell's sphere of work—it could mean nothing else—the delegates were empowered to say that the Society was disposed to join in the principle of a plan for the founding of an international combination of the more important societies and academies of the world was conceded, and, in fact, made the objective. The little set of foreign academies agreed, and the next move forward lay in the calling of a conference at Wiesbaden in the same year, to consider the general agreement previously arrived at, and to discuss the lines of establishment of the amalgamation thus forecasted. Here it is not out of place to recall that the English delegates on this occasion were Sir Arthur Rucker, Professor A. Schuster, and Professor H. E. Armstrong.

It is beyond the limit of our space to fully detail the subsequent and steadily progressive history of the movement for an international alliance. Statutes and laws were, however, formulated, and one by one the adhesion of the greater societies and academies of the world was obtained. The appointment of an international council was ratified, whose duty it should be to conduct the business of the Association in the intervals of the triennial meetings of a plenary General Assembly, such as that which has just concluded its deliberations. Further, the decision was taken that the first gathering of the latter body should be held in Paris in 1901—an event which virtually marked the birth of the International Association. To M. Gaston Darboux, the distinguished Permanent Secretary and *doyen* of the Academy of Sciences of Paris, fell the privilege of acting as President. By a unanimous vote London was then chosen as the venue of the next Assembly.

The delegates who have attended the Congress represented the full complement of constituent academical bodies, and were drawn from the cities of Amsterdam, Berlin, Brussels, Budapest, Christiania, Copenhagen, Göttingen, Leipsic, London, Madrid, Munich, Paris, Rome, St. Petersburg, Stockholm, Vienna, and Washington. In the case of London, the Royal Society delegation was composed of eighteen Fellows, including Sir William Huggins, its venerable President; while the British Academy, which is now, of course, within the pale of the Association, was represented by Lord Reay, the President, and six other Academicians. Among notable foreign men of science and of letters present were the Count de Franqueville, M. Moissan, Señor José Echegaray, President of the Royal Academy of Sciences of Madrid, Dr. Viktor von Lang, of Vienna, Count Balzani, and Prof. Svante Arrhenius, the eminent Swedish chemist.

Among the subjects that have been under consideration during the Congress may be mentioned a scheme for carrying on magnetic observations at sea, with the view of establishing a comprehensive magnetic survey around a parallel of latitude—a project requiring international co-operation to be completely successful. Seismological and geodetic investigations were under discussion—domains of inquiry in which scientific men of various nationalities are just now much interested. The British Academy promote a scheme for a lexicon of the Greek language; the Academies of Copenhagen and Berlin put forward a plan for a Corpus Medicorum Antiquorum. Then the important question of the establishment of an institute for the purpose of investigating the anatomy of the brain was under reference—a subject on which great unanimity prevails among foreign and English men of science. The above are instanced merely to indicate a few of the matters of scientific and literary interest that are before the Association in some stage or other.

The labours of the plenary Assembly were lightened during the period of meeting by a series of hospitalities planned by the Royal Society, the Lord Mayor, the University of London, and a number of representative men of science; those carried out by the last-named being of a particularly cordial and pleasant nature. In addition, the Universities of Oxford and Cambridge arranged visits, and the conferment of degrees upon certain of the foreign delegates took place.

REVIEWS OF BOOKS.

Aeronautics.—"My Airships," by A. Santos Dumont (Grant Richards; 6/- net), is not a student's book. It is a popular work, and it does not, even when judged by this modest standard, afford very much more information than the diligent newspaper reader might have gleaned from the files of the daily papers. It is prolific in anecdotes of M. Santos Dumont's adolescence, and it is charmingly illustrated by photographs of all his flying machines and most of his accidents. These photographs are indeed the most valuable feature of the volume, and furnish an idea of the evolution of the navigable form of air-ship, or balloon. M. Santos Dumont does not furnish any positive data as to the exact speeds at which he has been able to drive his ships; but he assumes that they travelled at a higher rate than that which Sir Hiram Maxim, for example, thinks that an airship of the balloon type can be driven. "When, therefore, I state that, according to my best judgment, the average of my speed through the air in those flights (flights with No. 6 in 1902) was between 30 and 35 kilometres (18 and 22 miles) per hour, it will be understood that it refers to speed through the air whether the air be still or moving, and to speed retarded by the dragging of the guide rope. Putting this adverse influence at the moderate figure of 7 kilometres ($4\frac{1}{2}$ miles) per hour, my speed through the still or moving air would be between 37 and 42 kilometres (22 and 27 miles an hour)." If this can be taken as trustworthy then there seems to be not the slightest reason why M. Santos Dumont should not "lift" the Grand Prize of $100,000 which the St. Louis Exposition is offering for the best average times made over a fifteen-miles triangular course, provided that the average speed is not less than $18\frac{3}{4}$ miles an hour. Two points are specially to be noted about M. Santos Dumont's method and the possibilities he claims for it. One is that he is never foolhardy, and keeps as close to the ground as he can, since nothing is to be gained by height. The other is that he maintains that the chief difficulty in driving against the wind is not the "push" against the front of the balloon ship, but the suction or pull at its stern. The defect of the compilation is chiefly one of omission. One might well imagine after reading "My Airships" that M. Santos Dumont alone had done anything worth recording in the sphere of balloon propulsion. A few allusions are made to M. Giffard's unproductive experiments of fifty years ago, but the very successful achievements of MM. Renard and Krebs, who practically accomplished almost as much as M. Santos Dumont has done, are merely referred to as "the trials of such balloons . . . in 1883 had been repeated by two constructors in the following year, but had been finally given up in 1885." And yet he says: "Before my experiments succeeded, were they not called impossible?" Moreover, no allusions whatever seem to be made to the Lebaudy balloon, which, according to all accounts, has surpassed the author's machines in speed, in distance travelled, and in the number of successful return trips.

Geology.—Messrs. Blackie and Son have published a fifth edition, revised, of Mr. Jerome Harrison's "Text-Book of Geology." It is an admirably compact text-book in its present form; the new photographs are as welcome as they were necessary; and the addition of a table showing the range in time of invertebrate fossils is extremely and distinctively useful.

Builders' Quantities. Mr. H. C. Grubb has written "Builders' Quantities" (Methuen and Co.) with the intention of giving sufficient and necessary information to technological students for the City and Guilds examination on the subject, and to candidates for the Board of Education examination on Building Construction. The book is eminently practical, and is not without acute interest for those whose dealings with builders consist solely in paying their bills.

Radium. "Radium, and All About It" (Whittaker and Co.), by S. R. Bottone, is a cheap handbook which does not justify its subsidiary title. It is, none the less, a handy summary of the more popularly interesting facts about radium, and it adds a rather hasty summary of some of the theories concerning radium activities, ending with the doubts cast by Sir W. Huggins' examination of the spectrum of radium on its final degradation into helium.

Entropy. Mr. James Swinburne repeats in "Entropy" (Constable) those views on thermodynamics which he has been repeating with considerable satisfaction to himself both before and since he read his disturbing paper on the "Reversibility of Thermodynamics" to the Physical Section of the British Association last year. Since its publication it has been denounced by the chief opponent of Mr. Swinburne's views as likely to be extremely disturbing to earnest engineering students; but it has at any rate been productive of some interesting and spirited rejoinders from Professor Perry. As an example of Mr. Swinburne's lively style, we may quote the following passage: "The unit of heat, which is quite an unnecessary nuisance, has no name, for British thermal unit is not a name; it is an opprobrious epithet."

"Metal Working," by J. C. Pearson (John Murray; 2s.), is an admirable guide to the practical manipulation of tools for the working of metals. The subjects treated of are divided under the various headings, such as "Filing," "Scraping," "Soldering," "Riveting," &c., and each operation is not only clearly described, but good outline figures and numerous photographs add greatly to the value of the descriptions, so that any one mastering this little work may consider himself a fairly expert metal worker.

BOOK NOTICES.

Flowering Plants and Ferns. A second edition of the "Manual and Dictionary of the Flowering Plants and Ferns" (Cambridge University Press; 10s. 6d.), which Mr. J. C. Willis originally wrote in two volumes, has now been published in a single volume to its great advantage in accessibility of information and general usefulness. Mr. Willis's work, modest in aim, and described by its author as a mere compilation, is of encyclopædic value to the student of botany. As in the first edition, its staple contents are a dictionary in which the whole of the families and the important genera of flowering plants are dealt with; and this general information is supplemented by special treatment in Part I. of the morphology, natural history classification, geographical disposition, and economic uses of the flowering plants and ferns. To the new edition has been added a mass of additional material; and new features are the articles on outfit, on collecting and preserving material, on observing and recording, and on general field work—a method of botanising which receives too little attention. We cannot pay the work a higher compliment than that of saying that Mr. Willis's expressed aim "to render the work sufficiently complete for the requirements of botanical students, schoolmasters, travellers, residents in outlying districts, and the considerable class of people who have an indirect interest in botany, and need some general work of reference on that subject . . ." has been completely and triumphantly attained. At the same time the student at home will be able to make constant use of it as a treatise of reference in general morphology and geology on plant distribution and systematic botany.

War in the Far East. We have received from Messrs. Virtue and Co. for review the first volume of a history of the Russo-Japanese War, "War in the Far East," by E. Sharpe Grew. Vol. 1, which is attractively bound and illustrated, deals with the preliminary history which led to the outbreak of war. The evolution of Modern Japan is traced; the relations of Japan with Korea and China are described, and an account is given of the Chino-Japanese War. It is shown how the intervention of European Powers in the settlement of Peace negotiations and the subsequent Russian encroachments led inevitably to the present crisis in the Far East.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

MITES.

Cecil Warburton, M.A.

(*Continued from page* 105.)

And now, perhaps, a somewhat more detailed account of the animals we are looking for may not be out of place. That they are not insects, but arachnids, is doubtless perfectly well known to readers of "Knowledge." They are without antennæ, and have normally eight legs when mature. The Oribatidæ are blind, but when eyes do occur in the mite tribe they are simple and not compound. The Arachnida of this country are represented by the spiders, the harvestmen, the "false-scorpions," and the mites. The false-scorpions, or Chelifers, are unmistakable, and the spiders are distinguishable at a glance from the mites because of the narrow pedicle or "waist" which joins the two portions of their body. The characters which separate the mites from the harvestmen are not quite so obvious, but the latter have the abdomen more or less distinctly segmented, and have always two eyes on a turret in the middle of the fore-part of the body. In practice there is little danger of confusing the two groups, as very few mites, except the easily recognised ticks, are equal in size to the smallest British Phalangids or harvestmen. All mites live on fluid nutriment, some deriving it from animals, others from plants, and their mouth parts are accordingly adapted for piercing and sucking. It will be useful, perhaps, to give in this place a short review of the principal acarine groups, and to indicate in a few words the general condition of our knowledge with regard to them.

First of all, then, we have two families of very minute worm-like mites, the Eriophyidæ (or Phytoptidæ) and the Demodicidæ. The former are generally known as gall-mites, and are responsible for various plant diseases, a familiar example being the disease of "big bud" in black currants, which is caused by *Eriophyes ribis*. The Demodicidæ are animal parasites, and the best-known example is *Demodex folliculorum*, parasitic in the hair follicles of man. Then follow the Sarcoptidæ, or itch-mites, extremely unattractive creatures, which are external parasites of various vertebrate animals. All the above, possessing a certain economic importance, have necessarily attracted more or less attention from those who study the diseases of animals and vegetables, but from the faunistic point of view there is much ignorance with regard to them in this country. For further information we may refer the reader to Neumann's "Parasites of Domesticated Animals," which has been translated by Dr. Fleming, and to Connold's handsome volume on "British Vegetable Galls."

We next come to the Cheese-mite tribe or Tyroglyphidæ, which feed chiefly on decaying animal or vegetable matter. They are a small group of soft-bodied mites, generally white in colour, and the British species have recently been monographed by Michael in the publications of the Ray Society. Then follow the Oribatidæ, with which we are principally concerned in the present paper, and they are succeeded by the ticks or Ixodidæ. Though their comparatively large size has probably made the ticks the most familiar examples of mites to the uninitiated, yet we are only beginning to know something about them, and recent investigations in their direction are again entirely due to their economic importance as the medium by which various dread diseases are communicated to man and domestic animals—chiefly in foreign countries. Neumann's "Parasites" may again be consulted, and the same author has written a Revision of the Ixodidæ, but the British ticks are only very slightly known.

The same may be said of the Gamasidæ, free-living predaceous mites, examples of which are sure to be found among the moss in which we are seeking the beetle mites. They run rather quickly and use their long front legs chiefly as feelers. A serious attempt to deal with the British species is very much to be desired.

Other families of free-living mites, also clamouring for attention, are the Bdellidæ or snouted-mites, and the Hydrachnidæ or fresh-water mites, and then we come to the Trombidiidæ, which include the velvety scarlet "harvest mites," and the Tetranychidæ or spinning mites, a familiar example of which is the "red spider," so obnoxious to fruit growers. Almost the only English work which professes to deal with these groups is Murray's British Museum hand-book entitled "Economic Insects—Aptera," a book necessarily long out of date, and not free from grave errors. It is abundantly clear, therefore, that much remains to be learnt with regard to the British Acari, some families of which are practically untouched by any recent investigator.

And now for a few final words concerning the Oribatidæ, which afford in many respects the best introduction to the study of the mite tribe. Four stages are distinguishable in the life-history of these mites—egg, larva, nymph, and imago. In some species the transformation or metamorphosis is very complete, there being hardly any resemblance between the nymph and the imago, while in others the change is not so striking. The eggs are relatively very large, and the larvæ which hatch out may be recognised as such by the fact that they possess only six legs. The fully-grown creatures are generally slow moving, and with hard or leathery integuments. Their body is usually pretty clearly marked off into two regions, the cephalothorax and abdomen, though only in one genus, *Hoploderma*, are these capable of independent movement. Whether a mite is an oribadid or not may be readily determined by examining the cephalothorax, for in this family there is always present a pair of curious sense organs known as *pseudostigmatic organs*. They are modified hairs, of varying shape, proceeding from the centre of two circular pits with raised edges situated near the sides of the hind part of the fore-body, near the commencement of the abdomen. Their peculiar shape and disposition are of prime importance in determining the species of one of these creatures. In the nymphs the legs always terminate in a single claw, but the imagos may be either monodactyle or tridactyle. The nymphs moult three times before the mature stage is reached, but in some cases the cast skins are never entirely thrown off, and the adult mite walks along with the three nymphal skins still adhering to its back.

These mites differ very much in the general appearance they present, some being smooth, glossy, and beetle-like, while others have a rugged, leathery appearance and are furnished with warty prominences, or bristle with hairs and spines. Some of the more hairy species have a remarkable habit which is a distinct nuisance to the collector. They cover themselves—doubtless for pro-

tective reasons—with particles of dirt, which entirely alter their appearance, and are by no means easy to remove completely, and these grotesque moving particles of dust and *débris* have to undergo very rigorous ablutions before they are ready for the cabinet.

Royal Microscopical Society.

April 20.—Dr. Hy. Woodward, F.R.S., Vice-President, in the chair. A large tank microscope, made by Thomas Ross, presented to the Society by the Committee of the Quekett Microscopical Club, was exhibited. It was made not later than the year 1870, and was designed for the purpose of examining objects contained in aquaria. It was a beautifully made and highly-finished instrument, having nearly every conceivable adjustment. The annual exhibition of Pond-Life was given this evening by Fellows of the Society, assisted by members of the Quekett Microscopical Club.

Quekett Microscopical Club.

The 413th ordinary meeting of the Club was held on April 15, at 20, Hanover Square, W., the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. A paper was read by Mr. W. Wesché, F.R.M.S., "On some new Sense-organs in the Diptera." The paper was well illustrated by diagrams and drawings. After briefly reviewing the investigations of Packard, Platten, Forel, Lubbock, and others into the senses of taste, smell, and hearing in insects, the author proceeded to show that he had found processes homologous with the "taste-hairs" of Kraepelin in some Orthoptera, Coleoptera, Diptera, and Hymenoptera. Organs were then figured on the antennæ of *Gastrophilus equi*, L., *Stratiomys chamæleon*, L., and *Bibio hortulanus*, L., which were thought to be typical olfactory organs. Both the antennæ and palpi of insects were considered capable of receiving the stimulus of several senses, but their capacities differed so much in various genera and species that a general rule could not be formulated. The author had found new sense organs on the femora of many Diptera which he was unable to assign to any sense of which we have conception. Other organs of quite different construction had been found on the tibiæ of some minute Empidæ. Their functions were quite unknown, and several experiments which had been made with a view of discovering the functions had yielded only negative results.

Journal of the Quekett Club.

The April number of this Journal, which has just reached me, contains several useful articles and notes, amongst which are a note by Mr. F. J. Cheshire concerning Abbe's test for aplanatism, and a simple apertometer derived therefrom, the apertometer being figured on a separate plate, so that it can be cut out and used on the microscope in the way described by the author. Mr. F. P. Smith, the new Editor of the Journal, contributes a note on the spiders of the sub-family Erigoninæ; Mr. Rheinberg a note on an overlooked point concerning the resolving power of the microscope; and Mr. Scourfield concludes his synopsis of the British fresh-water Entomostraca, including the Ostracoda, Phyllopoda, and Branchiura.

Microscopic Slides.

In the advertisement columns of this magazine will be found a notice relating to the sale of duplicates of slides from the collection of Mr. J. Hornell, of Jersey. Many of my readers will be familiar with these beautiful preparations, which include botanical as well as zoological subjects, and as they are now being dispersed, and are offered at quite nominal prices, I have felt myself justified in calling attention to them.

Practical Botany and Geology Classes.

I have been much interested in receiving from Mr. J. M. B. Taylor, Curator of the Free Museum at Paisley, particulars of field rambles held in that neighbourhood from April till the close of the public schools in July, with a view to giving students a practical acquaintance with nature. The plan is excellent, and well worth being taken up by other of our many Free Libraries. Excursions are held twice a week, namely on Wednesdays and Fridays, leaving Paisley at 5.40 p.m., or such other time as may be agreed upon, many of the excursions being in brakes so as to get well into the surrounding country. For the last five or six years during each session the class has brought in from its field rambles the typical wild plants, grasses, ferns, &c., of the time and district, and these have been placed on view in the Free Museum with their English and scientific names attached. Fresh specimens of plants were added twice weekly, and lists thereof published in one of the local daily papers. Nature knowledge was studied practically at these excursions with the help of the camera, a portable microscope, and a dredge for streams and ponds. At the New Year a four days' exhibition was also held. By the kindness of a local lady, Mrs. Polson, of Leven Castle, prizes of microscopes were offered to the members of the class for the best collection of dried, mounted, and named wild plants, grasses, and ferns; and a microscope was likewise offered to working men and women who would also make a dried collection, with names (which were obtained from specimens shown in the Museum), but who were not members of any class or Natural History Society, where names of plants were given. This prize was gained by an ex-mason. For members of the class each collection had to contain 400 specimens; and for the collection made by working men and women there must be 200 specimens. It is to be hoped that so excellent a scheme may find many imitators.

Notes and Queries.

Chrysanthemum Fungus. (C.H.C.)

I have submitted the chrysanthemum leaves to Miss E. M. Gibson, who has for some time been investigating this fungus in the Cambridge University Botanical Laboratories. I learn from her that it is quite a new species, having only been discovered some six or seven years ago, and has been described, as far as present knowledge allows, by Dr. Ernst Jacky, in the *Zeitschrift f. Pflanzen-Krankheiten*, Vol. X. (1900). It has been tentatively named "Uredo-chrysanthemi," but though Mr. Massee, in the *Gardener's Chronicle* speaks of other stages teleuto or aecidio spores have not hitherto been definitely found, or at least the evidence is not complete. Miss Gibson says she has herself quite failed to find any other stage than the uredo spores, as on the leaf you sent me. Apparently the fungus, though unquestionably injurious, is not necessarily destructive to the plants, but various species living under similar conditions, show a curious variation in susceptibility to attack, especially under high cultivation. So far the conditions favourable or otherwise to the fungus have also not been determined.

Making Rock Sections.

Mr. C. H. Caffyn, of Hornsey, writes with regard to rock sections: "I tried to make sections, as recommended in the text-books, with emery powder on a piece of zinc or glass, but it was a very long job, and the results were not altogether satisfactory, and were quite out of proportion to the time employed. I then thought it could perhaps be done with ordinary emery cloth, and I find this does very well, and takes much less time. I first chip off as thin a flake as possible, and grind one side flat on 'F' emery cloth. Then I use No. 1 and then No. 0, and then polish on a piece of No. 0 that has been rubbed down with a bit of itself to take the surface off. The piece of rock is then stuck on a bit of plate glass with ordinary mucilage—I use Stephen's gum. When dry, the rock can be rubbed down as mentioned above. Great care must be taken when rubbing on the No. 0 to finish, as the section is apt to crumble at the edges. When it is thin enough (which I generally judge by reading print through it), put the piece of glass and section in ordinary water till the section floats off the glass. Then wash with a sable brush to remove all gum. Soak in methylated spirit to remove water. Evaporate spirit, soak in benzene, and mount in balsam and benzole." Mr. Caffyn has sent me some slides to look at which have been made in this way, and which seem quite equal to those made by the ordinary process.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for June.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.51, and sets at 8.5; on the 30th he rises at 3.48, and sets at 8.18.

The sun enters the sign of Cancer on the 21st at 9 p.m., when summer commences.

The equation of time is negligible on the 14th.

Sunspots have been very conspicuous of late, whilst in addition spectroscopic observations of the Sun's limb have shown many fine prominences.

The positions of the spots with respect to the equator and axis may be derived from the following table:—

Date.	Axis inclined to W. from N. point.	Centre of disc, N. of Sun's equator
June 5 ..	13° 54′	0° 3′
,, 15 ..	9° 45′	1° 15′
,, 25 ..	5° 21′	2° 25′

THE MOON:—

Date.	Phases	H. M.
June 6 ..	☾ Last Quarter	5 53 a.m.
,, 13 ..	● New Moon	9 11 p.m.
,, 20 ..	☽ First Quarter	3 11 p.m.
,, 27 ..	○ Full Moon	8 23 p.m.
June 5 ..	Apogee	11 25 a.m.
,, 17 ..	Perigee	0 30 p.m.

Occultations.

The particulars of the only occultation likely to be observed during the month are as follows:—

Date	Star's Name	Magnitude	Disappearance	Reappearance.
June 24	θ Librae	4.3	11 55 p.m.	1 30 a.m. (25th)

THE PLANETS.—Mercury is a morning star in Taurus, he is at greatest westerly elongation on the 8th, when he rises about an hour in advance of the sun.

Venus is a morning star, but too near the Sun for observation.

Mars is in conjunction with Venus on the 19th, and therefore also out of range.

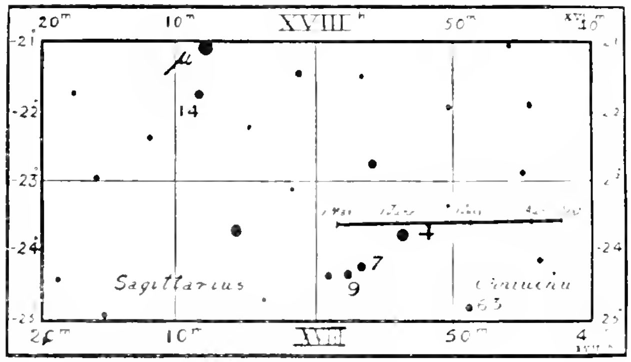
CERES.—The minor planet Ceres is in opposition on the 5th, when the magnitude is 7·4. On this date the asteroid has the same declination as the star ξ Ophiuchi but is 0h 18m 41s west of the star.

Jupiter is a morning star, rising about 1 a.m. near the middle of the month.

Saturn is in the eastern portion of Capricornus near the star δ; the planet is at the stationary point on the 1st, after which date his motion is retrograde.

On the 1st Saturn rises about midnight, and on the 30th about 10.15 p.m. The northern surface of the ring plane is presented to us.

Uranus is in opposition on the 19th, hence about this date he is on the meridian at midnight. The apparent diameter of the planet is 4″. In consequence of his low altitude, it is rather difficult to see the planet with the naked eye, but any slight optical aid renders him easily visible. The appended chart shows his position in Sagittarius.



PATH OF URANUS IN SAGITTARIUS:—

Neptune is in conjunction with the Sun on the 27th, and consequently is unobservable.

Comet a 1904. About the middle of April the first comet of the year was discovered in Hercules by Brooks, at Geneva, N.Y., U.S.A. It is a faint telescopic object, diminishing in brightness, and is slowly moving along the borders of Draco into Ursa Major. Early in June, it should be near the star ζ Ursae Majoris.

THE STARS:—

Positions of the stars about 10 p.m.:—

ZENITH . Great Bear, *Cor Caroli*.
NORTH . Ursa Minor, Cepheus, Cassiopeia.
EAST . Lyra, Aquila, Saggittarius, Cygnus.
SOUTH . Hercules, Ophiuchus, Corona, Libra, Scorpio.
WEST . Leo, Cancer.—S.W.: Virgo and Boötes.—N.W.: *Capella*.

TELESCOPIC OBJECTS:—

Double Stars:—β Scorpii, XVI.h0m, S. 19 33′, mags. 2·0, 4·0; separation 13″·1.

ε Lyræ, XVIII.h 41m, N.39° 32′. Quadruple star, better known as the "double-double." The star can be divided into two components ϵ^1 and ϵ^2 (mags. 4·6, 4·5; separation 207″) with the slightest optical aid and under favourable conditions the naked eye alone is able to effect separation; using a power of about 150 on a 3 or 4-inch telescope, each of these can again be divided, ϵ^1 mags. 4·7, 6·3; separation 3″·0; ϵ^2 4·9, 5·2, 2″·5.

ζ Lyræ, XVIII.h 41m, N. 37° 30′, mags. 4·3, 5·9; separation 44″. Very easy double; power 20.

δ Lyræ, XVIII.h 51m, N. 36° 49′, mags. 5·5, 5·9; naked eye double. Glorious field for low powers (*Webb*).

θ Serpentis, XVIII.h 51m, N. 4° 4′, mags. 3·9, 4·2; separation 22″. Fine pair in small telescopes.

Clusters and Nebulæ.—M80 (Scorpio). A compact globular cluster half way between α and β Scorpii; looks like a nebula in small telescopes.

M57 (Ring Nebula in Lyra). Easily found by setting the telescope ⅓ of the distance from β towards γ. Rather faint object, but readily seen as a small ring in a 3-inch; it is the only annular nebula visible in small telescopes.

Knowledge & Scientific News

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Contents and Notices. See Page VII.

Flower Mimics and Alluring Resemblance.

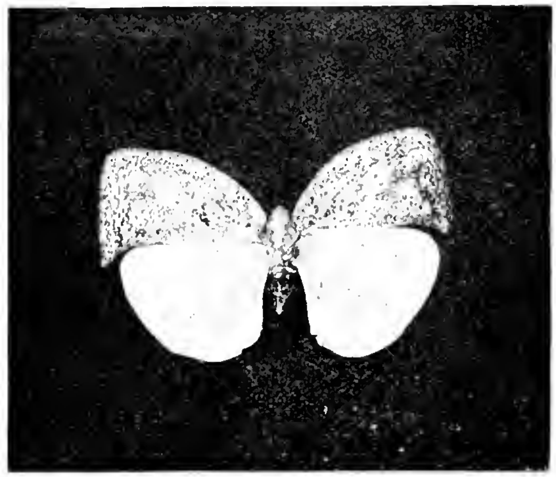
By PERCY COLLINS.

NOT the least curious insects which gain protection from their enemies by means of a likeness to surrounding objects are those which may be described as flower mimics. Of these, some remarkable instances have already been described, nor is it unlikely that others, equally striking, remain to be discovered. Among butterflies, one may often trace a likeness between the resting insect and the buds or blooms amongst which it has settled. This flower resemblance is seen in the case of our common "white" butterflies, which, when settled among such blossoms as those of the pea tribe, have an

Group of Orange-tip Butterflies and Cow Parsley.

undeniable general likeness to the unopened flowers. Again, a contributor to the *Speaker* recently pointed out the resemblance of the resting "wood white" butterfly (*Leucophasia sinapis*) to the flower buds of the corn wheat—a plant invariably abundant in the woods frequented by this dainty insect. The present writer is able to substantiate this observation, being familiar with one of the few remaining districts wherein the "wood white" is still fairly common.

A more specialised case of floral simulation is seen in the "orange-tip" butterfly (*Euchloe cardamines*), an insect familiar to all lovers of the outdoor world. The upper surface of this butterfly's wings are white marked with



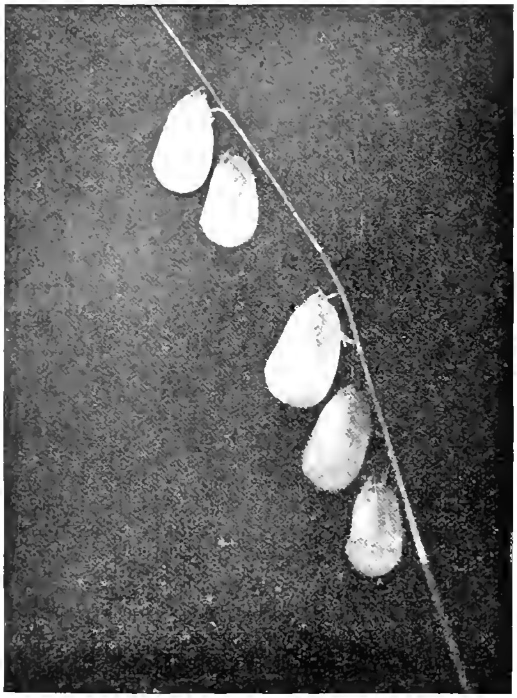
A Species of *Flata* from Perak. (Somewhat enlarged.)

black, with (in the male only) two large orange areas in the fore wings. The colouring of the underside, which is identical in both sexes, seems designed in imitation of a small truss of the tiny white florets of some umbelliferous plant, such as the hedge parsley. Such pale or white flower masses are among the commonest blossoms of the hedgerow in the springtime, when the "orange-tip" butterflies are on the wing. It is, of course, extremely doubtful whether the butterflies have any knowledge of their protective colouring; nor is there any ground for supposing that the insects select the neighbourhood of umbelliferous blooms as resting places. At the same time, it seems quite admissible to suppose that the colour likeness of *E. cardamines* to florescence common in spots frequented by the insect is likely to stand it in good stead as a protective disguise. The underside of the hind wings, between which the fore wings are folded when the insect is at rest, are mottled white and green—the white patches resembling tiny florets, while the green represents the background of vegetation against which they are supposed to be seen. Those who have not observed the "orange tip" butterfly in nature may judge of the closeness of the protective resemblance by a glance at the accompanying photograph.

Several of our common "blue" butterflies have wings mottled and spotted on the under surfaces in a manner which suggests the plantain heads and grass flowers among which these insects are accustomed to rest. And

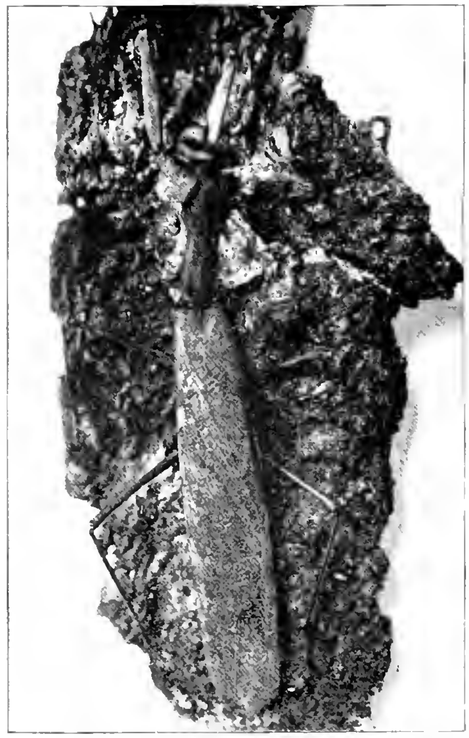
as these butterflies are accustomed to go to roost long before twilight has settled in, it is quite likely that their shape and colouring protect them from the attacks of birds.

Perhaps the most curious case of protective flower resemblance is that vouched for by Professor Gregory,



Individuals of a Species of *Flata* grouped upon a Plant Stem. Note flower-like appearance.

and described in his work, "The Great Rift Valley." The insect in question is a species of *Flata*, which is a genus allied to the scale-insects, and to the *Aphidæ*. The species described by Professor Gregory is indigenous to British East Africa, and is dimorphic—a certain number of individuals of each sex being bright pink in colour, while others are bright green. These insects resemble the green fly, or *Aphidæ*, in habits, sitting motionless on plant stems for long periods and feeding upon the sap. The manner in which the individuals of the present species are said to group themselves is very



Brown Mantid, from Usambava, at rest on bark.

remarkable. The pink ones sit upon the lower part of the stem, while the green ones have their place above, towards the extremity. Further, the developing larvæ, which secrete long filaments of a waxy substance, and are quaint, fluffy little objects, sit beneath the pink individuals at the lowest part of the stem. Thus, the exact appearance of a spiked inflorescence is simulated. The fluffy larvæ have a distinct likeness to seed pods. The pink individuals might be mistaken for drooping flowers, while the green ones, higher up the stem, look like so many undeveloped buds. Professor Poulton, however, has remarked that the grouping of green and pink insects in Professor Gregory's observation was probably accidental.

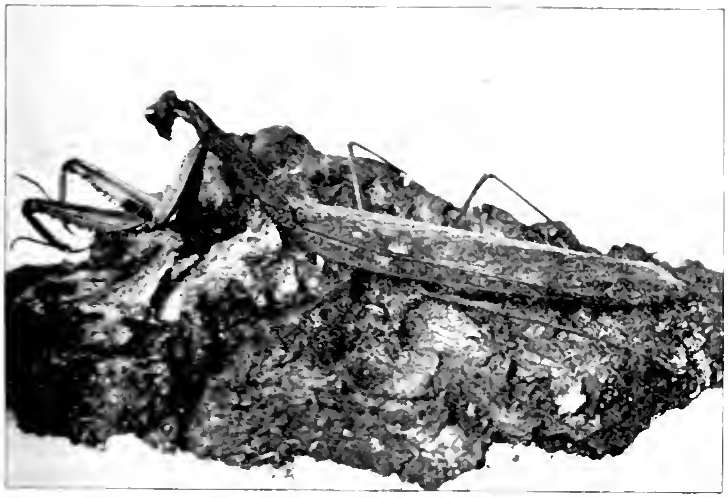
A green Mantid, from Ceylon, lying in wait among foliage.

So far, we have examined only instances of protective resemblance—instances, that is to say, in which the colours, or the colours and form, of an insect are seen to be of value to it as a means of escaping detection. We have now to consider cases in which the appearances of insects, while possibly screening them from the attacks of their enemies, have the additional advantage of enabling them to approach unobserved the creatures upon which they themselves prey. Such instances of resemblance may be termed aggressive.

The curious "praying insects," or *Mantidæ*, afford many striking examples of aggressive resemblance. The whole of this large family is insectivorous in habit, and the majority of

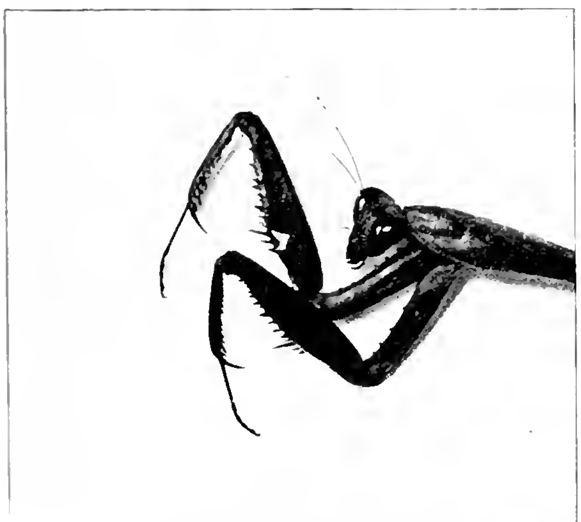
the species are either green or brown in colour. So that when sitting motionless among foliage, or upon the bark of trees, they are not only inconspicuous to such enemies as birds and lizards, but are also hidden from the small insects which form, in the main, their food.

The *Mantidæ* are almost all sluggish in their move-



Another view of same insect.

ments, seeming to be aware that the needs of their life will be best served by tranquillity, rather than by effort. They sit motionless in the sunshine—brown species upon bark, green species amongst foliage—and wait. At most their activity consists in a stealthy stalking among the leaves until they come within striking distance of their victims. The first pair of legs in *Mantidæ* is useless for



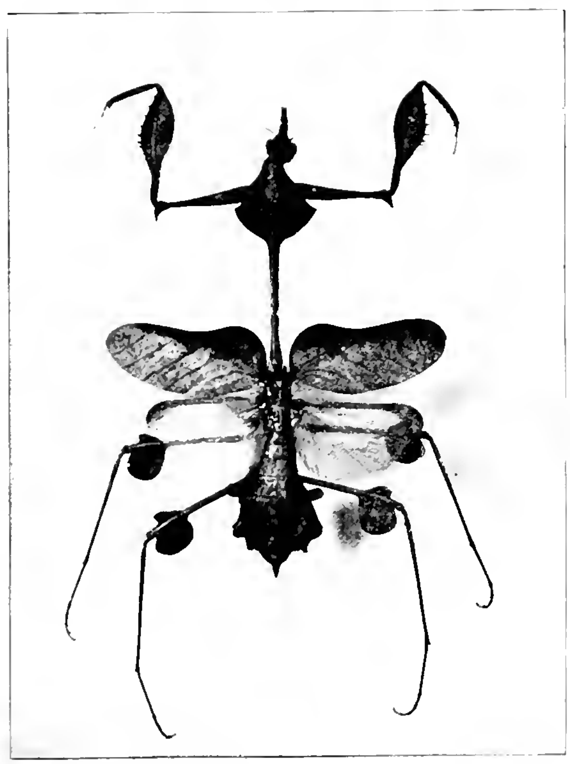
Raptorial Limbs of a Typical Mantid.

walking, but is wonderfully modified to serve as "clappers" for seizing prey. In the use of these limbs the insects are very rapid and dexterous, not only capturing insects which have settled upon a leaf, but even grasping them when actually on the wing. The rows of sharp spines with which the modified femur and tibia are armed make it impossible for the prey to escape when once the Mantis has seized it.

It has been said that most of the *Mantidæ* are either green or brown in colour. A few brightly-coloured species, however, have been described. The colours may be restricted to a certain area or may suffuse the whole surface of the insect. And when these insects assume their characteristic attitudes amongst vegetation, these colours often give them a curiously flower-like aspect. Now, it is well known that highly specialised flowers rely mainly upon the aid of insects to secure cross-fertilisation, and that honey is secreted as a bait to attract the winged visitors. It has, moreover, been demonstrated that the colours and markings of flowers attract honey-gathering insects. Bearing these facts in mind, it is not difficult to realise that a quaintly shaped and brightly coloured Mantis, hanging motionless among green foliage, might, at times, be mistaken by other insects for a flower. That such mistakes actually occur has been vouched for by several observers.

Dr. Wallace mentions an insect (*Hymenopus bicornis*), discovered by Mr. Wood Mason, which attracts insects to their destruction by its flower-like shape and pink or white colour. Parts of the insect's legs are so flattened as to simulate the petals of the supposed flower. In this instance, the whole of the Mantis looks like an orchid, but in the case of *Idolium diabolicum*, from Mozambique, a drawing of which is exhibited in the Natural History Museum at South Kensington, only the under surface of the thorax and fore-limbs have a flower-like colour and form. The body, wings, and hind legs are greenish or brown, in harmony with the foliage by which they are partially hidden when the insect is lying in wait for a meal.

Perhaps the most authentic instance of alluring resemblance is that described on the authority of Dr. J. Anderson. The Mantis is *Gongylus gongyloides* from Southern

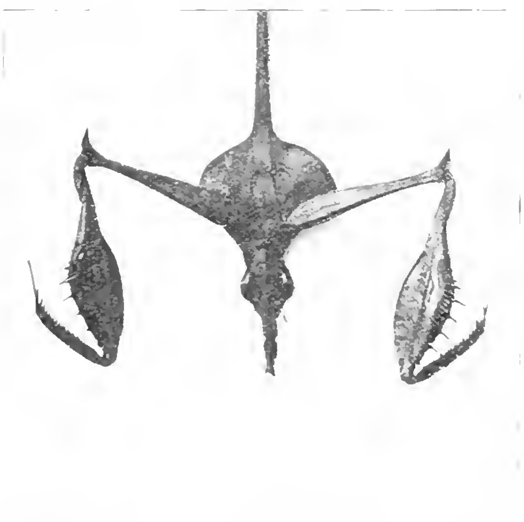


Gongylus Gongyloides, **from Southern India.**

India—a species which has been known to naturalists for upwards of three centuries, but of whose strange habits nothing was discovered until comparatively recent years. Living examples of *Gongylus* have been thus described:* "On looking at the insects from above they did not exhibit any very striking features beyond the leaf-like

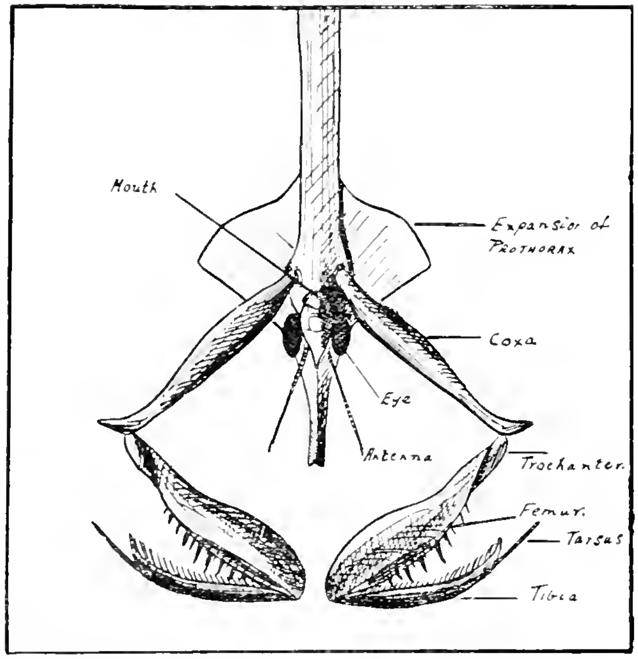
Prothorax, Raptorial Limbs and Head of *G. Gongylodes* in Flower-mimicking pose. The insect is hanging head downwards.

expansions of the prothorax and the foliaceous appendages of the limbs, both of which, like the upper surface of the insect, are coloured green, but on turning to the under surface the aspect is entirely different. The leaf-like expansion of the prothorax, instead of being green, is a clear, pale lavender-violet, with a faint pink bloom



G. [illegible] as above. Raptorial Limbs expanded to seize prey.

along the edges of the leaf, so that this portion of the insect has the exact appearance of the corolla of a plant, a floral simulation which is perfected by the presence of a dark, blackish-brown dot in the centre, over the prothorax, and which mimics the opening to the tube of a corolla. A favourite position of the insect is to hang head downwards among a mass of green foliage, and, when it does so, it generally remains almost motionless, but, at intervals, evinces a swaying movement as of a flower touched by a gentle breeze; and while in this attitude, with its fore-limbs banded violet and black, and drawn up in front of the centre of the corolla, the simulation of a papilionaceous flower is complete. The object of the bright colouring of the under surface of the prothoracic expansion is evident, its purpose being to act as a decoy to insects, which, mistaking it for a corolla, fly directly into the expectant, sabre-like, raptorial arms of the simulator."



G. Gongylodes. Key Diagram of Prothorax, Raptorial Limbs and Head; and Ventral Surface; Insect hanging head downwards.

A more perfect combination of protective and alluring resemblance than the above could hardly be conceived. The green colouring of the body and legs of the *Gongylus* harmonises with the foliage amongst which it rests, and affords an effective hiding from the sharp eyes of insectivorous birds. The unusual shape and brightly-coloured under side of its prothorax and fore-limbs constitute a lure, by means of which the Mantis attracts to itself the smaller insects upon which it feeds.

Colour-Pattern in Beetles.

In Vol. X. of the Decennial Publications of the Chicago University, United States, W. L. Tower gives the results of his study of the development of colour and colour-pattern in beetles and other insects. The colours of insects are of two kinds. On the one hand, there is the dermal or typo-dermal coloration, coeval with the group itself, and disposed in spots and strips correlated with the underlying vital organs. On the other hand, there is the coloration produced by scales or modified hairs, which is of much later origin. The latter type of colouring is solely ornamental, its development has had no relation to the vital organs, and is, consequently, much more diverse than the original colouring, which it tends to obscure. A good example of the difference between these two types of colouring may be observed in the contrast between the dull browns and yellows of the ground-beetles of the Catabus genus, and the gay colouring of the Vanessa group of butterflies. Dermal colouring begins in the fore part of the body, where the muscles first harden, and thence spreads to the back. It is obviously concerned with the hardening of the Cuticula, which has a tendency to turn brown, a fact which accounts for the predominance of browns and yellows common in beetles and cockroaches.

* Pro. Asiat. Soc. Bengal, 1877, p. 193

The Influence of Fungi

For Good on Other Forms of Life.

GEO. MASSEE, F.L.S.

IN discussing the various phases included under the subject of the influence of fungi as favouring, either directly or indirectly, the welfare of other forms of life, in the order of their relative importance, the first to claim attention is that of fungi playing the part of vegetable scavengers.

When bread, cheese, or other organic substances become muddy or mildewed, the general opinion is that a certain amount of decay has taken place, and therefore mildew appeared as a consequence of such preliminary decay. This idea, however, is not correct, the mould or mildew being the original cause of decay, or change of composition of the body attacked. The spores of fungi are always present in large quantities in the air, and consequently alight on everything not specially protected. The reason why mouldy food is not universal, seeing that it is so much exposed to the air, is due to the fact that fungus spores can only germinate, and produce a vigorous mycelium, under certain well-defined conditions as to temperature, moisture, and the supply of proper food in an available form. The conditions under which fungi can grow most vigorously varies for every kind. Taking temperature, there is a maximum and minimum of heat, above or below which the spores cannot germinate, hence no growth takes place; somewhere between these two extremes there is an optimum point, at which the spores germinate and form the most vigorous mycelium, provided other conditions are also favourable.

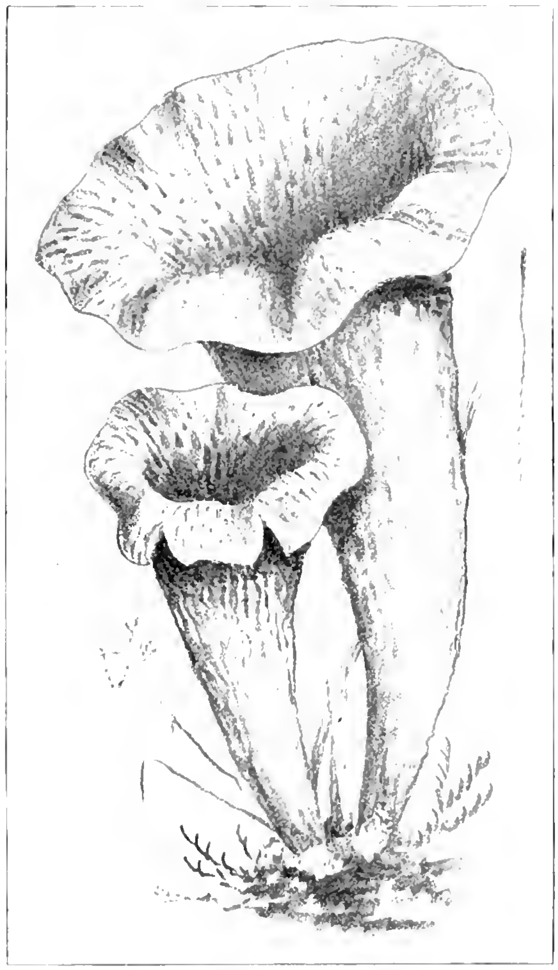
Cold storage, whether practised in the primitive manner of placing cooked food in a cool place; the freezing of raw meat; or the storing of ripe fruit in a cool room for preservation, simply means keeping the substance at a temperature below the minimum point at which the spores of the fungus or bacterium known to attack such substance can germinate.

No fungus spore can germinate in the absence of moisture. Again there may be too much or too little water for very robust growth, and in the case of heat, there is an optimum or best proportion under which growth proceeds most actively.

Some few fungi, as the common blue-green mould (*Penicillium glaucum*), and the grey mould (*Botrytis cinerea*), show little or no discrimination in the choice of food, and may appear on almost every kind of dead or decomposed plant remains, and also on many animal products. The majority of fungi are, however, very fastidious in the selection of their food, numerous parasitic species being confined to one particular kind of host-plant; whereas some fungi have carried this selective power to such an extreme as to be actually limited to one particular variety of a species for their food supply.

As scavengers the fungi mostly exercise their influence on members of the vegetable kingdom. Leaving for future consideration the havoc wrought by parasitic fungi on perfectly healthy and vigorous plants, we have still left a very large number known as *saprophytes*, a term which includes all fungi that obtain their food from dead organic matter.

When leaves fall in the autumn, or dead branches fall to the ground, or even when whole trees are blown down, the current opinion is that they decay as a matter of course; but no one who has not studied the matter can realise the influence exercised by fungi in hastening their decay, and the comparatively rapid conversion of such dead substances into water, gases, and soluble



1. "Horn of Plenty" (*Craterellus cornucopioides*); **Nat. size. An edible fungus.**

salts, which can again at once be utilised as food by other plants.

It is almost impossible to examine any twig or leaf that has been lying for some time on the ground, without detecting the presence of fungi, either under the form of mycelium in the tissues, when examined under the microscope, or as fruit in the form of a toadstool, etc., on the surface. Now these fungi have fed on the twig or leaf—in other words, have converted part of it into a toadstool. The latter soon perishes in turn and becomes converted into water, salts, etc., as stated above. This condition of things continues until the leaf or twig becomes thoroughly disintegrated and crumbles

to powder, forming humus in which other plants can grow and find food.

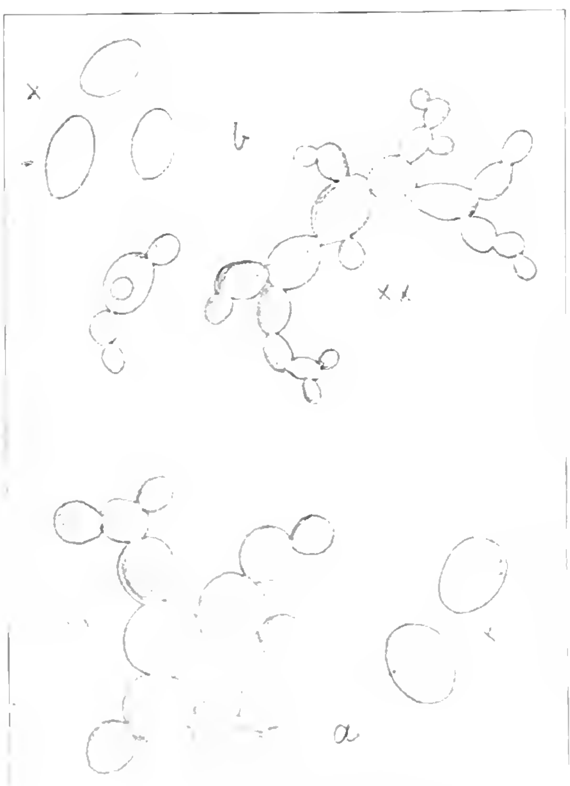
Finally, fungi are responsible for the hollow trunks of trees. The fungus first gains an entrance into the tissue of the trunk through the end of a broken branch, careless pruning, the hole made by a woodpecker, or some other accidental wound. Once in the tissues the mycelium spreads quickly, and in the course of time the heart-wood is rendered brittle, and eventually becomes resolved to powder, which is removed by wind and rain through any openings that may exist, and a hollow trunk is the result.

The almost constant presence of moisture, and varying temperature, are the main factors that admit of fungi effecting the rapid disintegration of dead vegetable matter in woods, etc. As is well known, wood that has been properly seasoned remains sound for centuries, but if allowed to become damp, then fungus scavengers, under the guise of "dry rot" (*Merulius lacrymans*), or other forms, at once commence the work of disintegration.

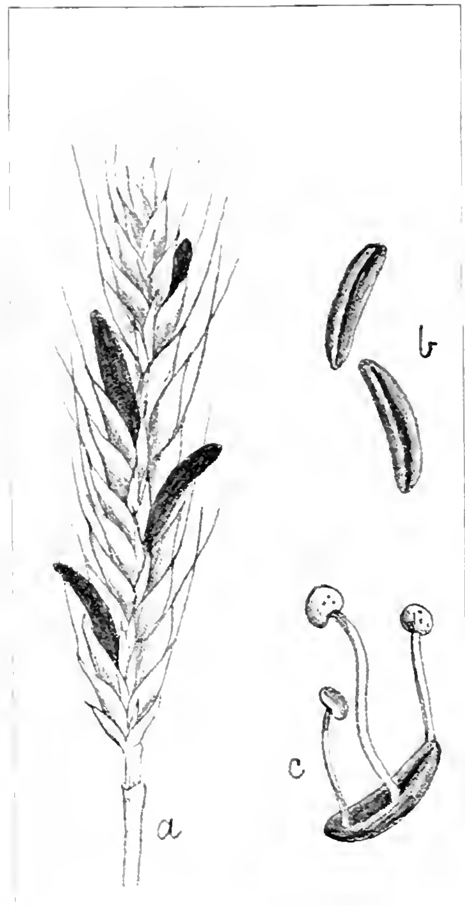
As an article of food, the nutritive properties of fungi have been much over-rated in the past. It was pointed out that owing to their nitrogenous nature they stood on a par with animal food, whereas in reality modern analysis proves that the composition of fungi varies very much in different kinds; and from a nutritive standpoint the common mushroom (*Agaricus campestris*), the kind most generally eaten in this country, ranks with cabbage rather than with beef.

This fact, however, by no means proves that fungi are comparatively useless as food; in fact, the oyster, from the purely nutritive standpoint, ranks little above fungi and cabbage, nevertheless it is considered a luxury; and in the same sense, fungi may be regarded rather as luxuries than otherwise, and are of use in rendering more pleasant to the palate substantial articles of food.

There are in Britain at least fifty different kinds of fungi that have been thoroughly tested as to their edible



2. **Yeasts; *a*, beer yeast (*Saccharomyces cerevisiae*), x, single plants; xx showing reproduction by budding; *b*, wine yeast (*Saccharomyces ellipsoideus*), x single plants; xx showing reproduction by budding. Mag. 800 times.**



3. **Ergot (*Claviceps purpurea*); *a*, growing on an ear of rye; *b*, ergot removed from its host-plant; *c*, ergot producing its second form of fruit after lying on the ground throughout the winter. Nat. size.**

properties, and from amongst these the great variety presented, so far as taste and aroma are concerned, is undoubtedly sufficient to meet the requirements of the most fastidious.

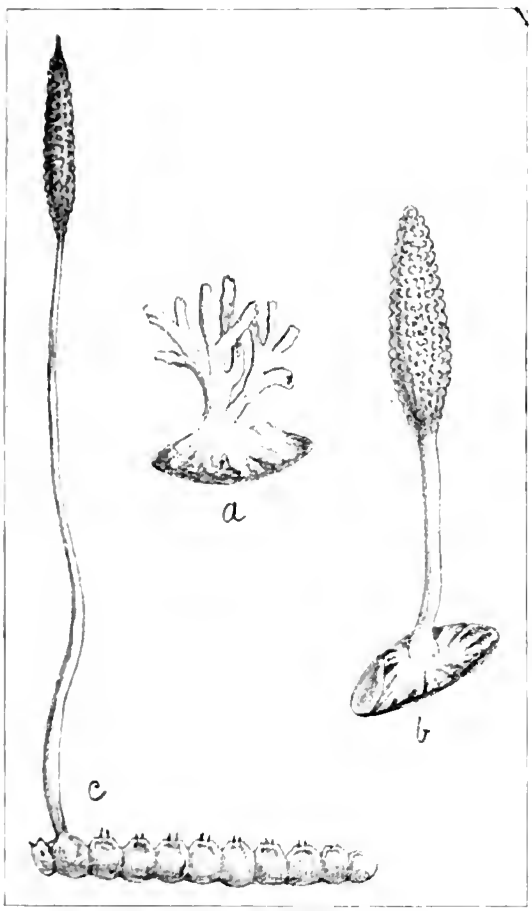
Aroma is most pronounced in the subterranean fungi, which include several edible kinds of truffle. The use of the strong smell to these fungi is to indicate their presence to various animals to whom they serve as an article of food; by this means the spores are dispersed.

From among the number of species eaten in England by mycologists, the one we consider best of all is a fungus which, although by no means uncommon, and during certain seasons very abundant on the ground in woods, is probably quite unknown to the majority of people. It is known as the "horn of plenty" (*Craterellus cornucopioides*), on account of its resemblance to the allegorical Cornucopia, as represented in pictures. The general form is that of a long, narrow funnel with a wavy mouth, two to four inches high, inside blackish-brown, outside grey. This fungus cannot possibly be

mistaken for any other less desirable kind, and when the first prejudice has been overcome, it will doubtless be added to the list of table delicacies.

A peculiar fungus of a somewhat gelatinous consistency and brownish-red colour, having a resemblance in shape a human ear, and popularly known as "Jews' Ears" (*Hirneola auricula-Judae*), is not uncommon on dead elder trees, and although not usually included under edible species in this country, is perfectly safe to eat, and a closely-allied species (*H. polytricha*) is esteemed as a luxury by the Chinese, by whom it is cultivated on a large scale. When dried, the price of this fungus ranges from £30 to £50 per ton, the retail price being about one shilling per pound. This fungus occurs in abundance in New Zealand, where it is collected for the Chinese market, the annual value of the exports ranging between £15,000 and £40,000.

These amounts are, however, entirely eclipsed by the hundreds of millions of pounds sterling expended



4. **Fungi growing on insects;** *a, b, Cordyceps militaris*; *a,* **conidial;** *b* **axiferous form of fruit; both are growing on the chrysalis of some insect;** *c, Cordyceps* [illegible], **growing on a caterpillar. Nat. size.**

annually on products depending entirely on the work done by a few closely allied and lowly organised species of fungi known as Yeasts (*Saccharomyces*). The products alluded to are fermented or alcoholic liquors; wines, beers, and home-made ginger-beer alike owe the amount of alcohol they contain to the activity of yeasts.

The yeasts are very partial to sugar as food; in the production of wine, the sugar is present in the juice from the crushed grapes; in brewing beer the starch present in barley is converted into sugar during the preliminary process of malting. In either case yeast is added to the sugary extract, and when the proper temperature is maintained, fermentation takes place. Such fermentation is the index of the vital activity of the yeast or fungus present in the solution.

Under such favourable conditions as regards temperature and food supply the yeast grows very rapidly, increasing in numbers by a rapid vegetative or non-sexual method called budding. During this activity the sugar is used as food, and the by-products, or those portions of the sugar not utilised by the fungus, are given off under the form of carbonic-acid gas and alcohol respectively. The former is the cause of the bubbling or effervescence as it escapes into the air, the latter remains in the liquid.

In olden times, the sweet wort or grape juice was left exposed to the air, and fermentation was effected by yeast cells present in the air coming into contact with the liquid. At the present time the yeast is added to the liquid, and in some breweries pure cultures of different forms of yeast are used, depending on the quality, flavour, or keeping power of the beer desired.

Yeast is quite as indispensable to the baker as to the brewer. To the latter it has been shown that alcohol is the by-product of most value; whereas to the baker, who utilizes the yeast for the purpose of leavening his dough, the carbonic-acid gas is most important. The fungus, being thoroughly mixed with the dough containing sugar and water, commences active growth, and the carbonic-acid gas liberated bubbles up through the tenacious dough and converts it into a light, spongy mass. The alcohol formed is dissipated during the process of baking.

With one important exception fungi are not used medicinally, unless the famous Chinese fungus is admitted. The one included in the British Pharmacopoeia is Ergot (*Claviceps purpurea*), the sclerotium of a fungus parasitic on the ears of rye and numerous other grasses, and has a wide distribution.

When flowers of rye, wheat, or pasture grasses are infected by the spores of ergot floating in the air, the part developing into a grain under normal conditions becomes changed into a black, horn-shaped body about half an inch in length, and composed of a solid mass of mycelium, termed a sclerotium; this is the Ergot, or part used medicinally. It contains a substance called Ergotine, which, although poisonous, is of great value as a medicine.

When the Ergot is mature its surface is covered with myriads of very minute conidia or summer-spores, which are immersed in a somewhat viscid, sweet substance that is very attractive to flies and other small insects, who, in visiting one grass flower after another, disperse the conidia, and thus effect the distribution of the fungus. When the grass dies in the autumn the Ergots fall to the ground, and remain unchanged until the following spring, when a new form of fruit grows from the sclerotium, the spores of which infect the grass flowers in the spring.

Notwithstanding its medicinal value, Ergot is said to cause serious diseases to human beings when it is ground up along with grain to form flour, and when eaten by horses or cattle it causes abortion.

The Chinese fungus alluded to, and called "summer plant, winter worm" by the Celestials (*Cordyceps sinensis*), is interesting as being one of a small group of fungi that develop on living insects. Some attack moths, wasps, &c., but the majority are met with on

caterpillars. Although the caterpillar is alive when infection takes place, it slowly dies, and its body becomes filled with a dense mass of mycelium, from which one or more simple or branched, elongated fruiting bodies spring at a later period.

One very beautiful fungus belonging to this section is not at all uncommon in this country, it is called *Cordyceps militaris*, and is generally found growing up amongst moss in damp places in woods. It is club-shaped, one to three inches high, and of an orange-red colour. If the stem is carefully followed down, it will be found to spring from the pupa of some moth or butterfly.

At the present time the knowledge that certain fungi attack and destroy insects has been turned to practical account. Fungi attacking insects injurious to crops, as locusts, cockchafers, &c., are cultivated on a large scale for the purpose of securing quantities of spores. These spores are preserved in small sealed glass tubes until required. When an army of locusts appears the contents of one or more tubes are mixed with water and placed on bread or some other substance eaten by the locusts. The spores thus eaten germinate quickly in the bodies of the insects, and death soon follows. Now as it is the custom among locusts to eat their dead friends, the infection spreads at a great rate. By such means large areas have been cleared of destructive locust swarms in South Africa and elsewhere.

Before the discovery of lucifer matches, a large hoof-shaped fungus (*Polyporus fomentarius*), growing on the trunks of trees, was used throughout Northern Europe for making amadou or tinder. The thick, brown woody flesh of the same fungus, cut into slices and beaten until it assumes the appearance of felt, is used at the present day in Germany for the manufacture of chest protectors, caps, purses, bedroom slippers, and various other articles. A good assortment of such, along with examples of the fungus and the felt, are exhibited in the Cryptogamic room, No. 2 Museum, Kew Gardens, where many other interesting forms of fungi are also on view.

The fact that Lichens differ from other plants in being partly fungal and partly algal, the two collectively constituting the plant, is well known. This condition of things is called *symbiosis*, *mutualism*, or *commensalism*; which means that each benefits respectively by the particular kind of work done by its neighbour, the total result of such mutualism being that Lichens can grow luxuriantly in localities where neither fungi nor algæ, as independent plants, could flourish. It is important to understand clearly the difference between a parasitic and a symbiotic fungus. The former is always injurious, without benefiting in any way the plant it is parasitic upon. The symbiotic fungus benefits, without in any way injuring, the plant it is associated with.

Symbiosis between fungi and other plants has of late years been shown to be much more general than was suspected. In many forest trees, as spruce, larch, silver fir, oak, beech, hazel, &c., the fine rootlets that supply the plants with food are entirely surrounded by a dense weft of fungus mycelium, which acts on the humus in which the plant is growing, in other words, converts the humus into food that can be absorbed by the root of the tree from the fungus surrounding it. The fungus and the rootlet it surrounds is called a *mycorhiza*.

Heaths, orchids, ferns, and all flowering plants not possessing chlorophyll possess mycorhiza, on which the last named are entirely dependent for their food supply.

Fasting Animals.

By R. LYDEKKER.

THE fact that a large number of species of mammals and other animals undergo more or less prolonged and continuous fasts during the period of their winter or summer sleep is familiar to us all. And although undoubtedly remarkable, the phenomenon is not such as to excite any great wonder or surprise in our minds; for during the periods of such slumbers the more active functions of the body are to a great extent suspended, while those that are carried on act slowly and entail comparatively little waste of tissue and energy. Moreover, before the period of the winter torpor or hibernation takes place, many of these animals, such as bears, accumulate large stores of fat on various parts of the body, which suffices to supply all the waste entailed by the respiratory function during the period in question. Fat is also accumulated by certain species, such as the mouse-lemurs of Madagascar, previous to the summer sleep, or æstivation, and is used up in a similar manner; such summer sleeps being, it should be noted, undertaken for the purpose of avoiding the season of great heat and drought, when food is difficult or impossible to procure. Other species, on the contrary, like squirrels, dormice, and hamsters, lay up supplies of food in their winter quarters, on which they feed during waking intervals in the torpor, so that the fast is by no means so prolonged or so continuous as in the case of the first group. There are, however, yet other animals, such as bats, among mammals, frogs and toads among amphibians, and the West African lung-fish among fishes, which apparently neither put on fat nor lay up a store of food during their period of torpor; which in the case of all of them is unusually prolonged. Bats, for instance, generally remain torpid throughout the winter months; while the African lung-fish passes the whole of the dry season comfortably curled up within a nest formed by the caked and dried mud of the river bed. In all these latter cases the fast must accordingly be prolonged and of a severe type.

Nevertheless, whether partial or continuous—whether mitigated by a store of fat or food or not—all such fasts, as already said, take place when the chief functions of the body are more or less completely in abeyance.

In marked contrast to the above is the case of certain members of two widely sundered groups of animals, which undergo a protracted voluntary fast during the breeding season, when the bodily functions are in their highest activity, and there is a strain on the whole system which is unknown at other times. How the creatures manage to exist at all under such circumstances is little short of a marvel; nevertheless, not only do they exist, but for the greater portion of the time they are in the very pink of condition, and it is only when the breeding season is over that they fall away and require a period of rest and good feeding in which to recruit their energies.

The creatures in question are the sea-lions and sea-bears on the one hand, and the salmon on the other.

The fact that the adult males of sea-lions and sea-bears, which constitute the family of eared seals, or *Otariidæ*, fast while on shore with their "harems" during the breeding season has been known for a long time; but it is only recently naturalists have satisfied themselves that the salmon abstains from food, almost,

if not quite, entirely during the period of its sojourn in fresh water.

As regards the fasting of the eared seals, we may take the case of the fur seals on the Pribiloff Islands, in Bering Sea, as described by Messrs. Jordan and Clark in the Report of the United States Fur Seal Investigation, published in 1898.

As regards the females, or cows, it is stated that after their first landing they do not leave the islands for ten or twelve days, during which period they must, of course, abstain from food. Whether such periods of fasting are regular or not is, however, at present unknown; but it is certain that neither the cows nor the young bulls (bachelors) fast for any considerable part of the summer, if for no other reason, from the circumstance that they maintain a uniform condition throughout the season, always showing a plentiful stock of blubber, and never looking worse at one time than at another.

Very different is the case with the old bulls, which come ashore about May 1, and do not again go to sea till about July 25, during the whole of which time they remain entirely without food. Like many hibernating mammals in autumn, they are quite laden in spring with fat or blubber, which is gradually absorbed while on shore, leaving the animals thin and greatly reduced at the close of the breeding season. With regard to the condition of the old bulls as they leave the islands after their long fast, some degree of misconception appears to obtain, for although they are undoubtedly much reduced in condition as compared with their state in the spring, yet they are by no means so poor, either in body or spirit, as has been reported. So long as they remain on the breeding-grounds they retain sufficient fighting power and courage to make themselves masters of the situation, and it is only when they move down to the sandy beaches, preparatory to taking to the water, that they become tame and tractable.

Turning now to the case of the salmon, it may be mentioned that, so long ago as the year 1880, Professor Ruesch published a report upon observations made on Rhine salmon, which tended to show that while in fresh water these fish, contrary to popular opinion, seldom or never feed. In fact, among two thousand salmon examined, in only two—and these kelts, or out-of-condition fish—was any trace of food found in their stomachs, which in most cases were wrinkled up and contracted, showing that they had not contained food for a long time. These observations have been fully confirmed by the experiments and examinations recently undertaken on behalf of the Fishery Board for Scotland; while these, again, have been checked, and in some measure corrected, by the independent investigations of Dr. K. Barton. The net result of all these observations is to render it practically certain that from the time they leave the sea until the completion of the spawning operation salmon, as a rule, take no food of any kind. As regards kelts, or spent fish, much the same appears to be true in their case also, but from time to time traces of food have been detected in the stomachs of such fish, showing that they occasionally seize and swallow a tempting morsel. In some slight degree the latter circumstance tends to confirm the popular idea that kelts are more greedy than salmon; the term "hungry looking kelt" being common among fishermen. Nevertheless, the popular idea is in the main wrong, since most kelts (unless, perhaps, in cases where they are prevented from getting back to the sea owing to the lowness of the water) fast as completely as salmon while in fresh water. It may therefore be taken as an established fact that the true feeding-ground of the salmon is the ocean, and that while in fresh water these fish preserve a more or less strict and complete fast.

Much the same is true of the Pacific species of salmon, which belong to a distinct genus (*Oncorhynchus*), and afford a large proportion of our supply of tinned salmon. After leaving tidal waters the throat of these fishes becomes contracted, and their stomachs are almost always found to be empty.

"The tendency to feed," write Messrs. Townsend and Smith, "becomes less the longer they remain, and when one has seen the enormous runs of salmon that sometimes actually crowd the streams, so that it would be impossible to wade without stepping upon them, it becomes apparent that they could not make their rapid journeys to the head waters of the largest rivers and have time to feed, and that there could not be food enough to supply them if they required it. If such hordes should become hungry while on the spawning grounds hundreds of miles from the sea, one could imagine the effect on the spawning operations.

"As a matter of fact, the salmon, after leaving tide water, lives on its own supply of fat and blood. Its flesh becomes less and less red, and the fish becomes thinner as it advances up stream. . . . .

"The degree of emaciation reached and the extent of the injuries received by the salmon by the time it has spawned preclude the possibility of its recovering, even if it reaches salt water alive. Death is a natural result of the conditions."

In thus starving and spawning themselves to death Pacific salmon (of which there are several kinds) differ markedly from our own *Salmo salar*—by far the finer and nobler fish—which may return to its spawning-grounds for several years in succession.

As regards the origin of the fasting habit in salmon, it might at first sight be supposed that all the members of this group were originally sea fish which acquired the habit of entering rivers to spawn, and that, finding the food to be obtained in fresh waters unsuitable to their taste, they refrained from feeding. Apart, however, from the question whether the group may not have been originally a fresh-water one, there is the fact that young salmon—parr and smolt—feed greedily in rivers, where the former are hatched.

The authors here cited suggest that, "in the process of evolution, the salmon may have lost the desire to feed in fresh water through the competition met with in the ascent of the rivers, the great distance to be traversed, and the lack of food in any stream necessary to supply as greatly increased a population of fishes as occurs in the spawning season."

Whether or no this be the true explanation in the case of the members of the salmon group, the voluntary fast undertaken during the breeding season by those fishes, and by the old males of the sea-lions and sea-bears, is one of the most wonderful physiological phenomena to be met with in the whole realm of organised nature.

A CONTINENTAL invention for automobile signals makes whistles of the hollow spokes of the wheels. These are operated by the air action of the wheels in turning, and controlled by a series of small rubber balls. The balls are controlled from the seat, their release opening the valves in the spokes and producing a peculiar whistling noise easily heard above the noise of traffic.

Photography.

Pure and Applied.

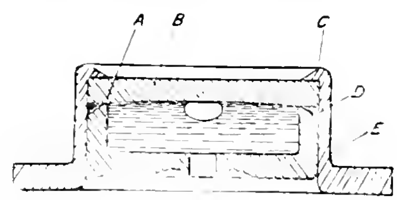
By CHAPMAN JONES, F.I.C., F.C.S., &c.

AT the recent conversazione of the Royal Society there were many exhibits that owed their origin, at least partly, to photography, such as an optical bench for testing lenses, by Messrs. R. and J. Beck, three-colour photographs projected by a lantern in which spectrum colours were used instead of coloured screens, by Sir W. de W. Abney, and photographs and photo-micrographs of various kinds. But the exhibits that seemed to me the most striking were the stereoscopic transparencies, by Mr. Francis Fox, of the Simplon tunnel, now in course of construction through the Alps, and of the Victoria Falls, and also some three-colour lantern slides by Mr. E. Sanger-Shepherd. The first showed how perfectly stereoscopic transparencies, well mounted, convey an impression of the actual object. And when such views are supplemented as these were by samples of the rock taken from the tunnel, one obtains as good an idea of the actual circumstances as is possible without visiting the place itself. Indeed, it is doubtful whether a visit would give much more information to the ordinary observer. The three-colour lantern slides were of various spectra, and produced with such a degree of fidelity that they might well be used for lecture demonstrations when it is desired to show spectra rather than the means of producing them. If, for example, it were wished to show the spectra of the rarer gaseous elements recently isolated, the use of such slides would give quite as good, if not better, results than the production of the actual spectra, without the cost and risk of employing tubes of the gases themselves, and the trouble of fitting up spectroscopic apparatus. Moreover, the slides would probably give a more representative effect, because they would be made under the most suitable conditions, instead of having to get the result during the exigencies of the lecture, and the projection on a screen would be much preferable to the necessity that often arises in such cases of providing instruments for the direct eye observation of the few members of the audience that are fortunate enough to gain access to them.

Reversal.—The reversal of the image is one of the most interesting and mysterious of photographic phenomena. Professor R. W. Wood has catalogued five kinds or types of reversal, and it has been suggested that at least one more should be added to these. I think, however, that these should be called methods rather than kinds of reversal, and believe that there is good reason for considering that there are probably only two kinds of reversal, which I suggest might well be called progressive and retrogressive respectively. That is one in which the effect of the light action is continued, and one in which it is undone. If the effect is regarded as a rotary one, then that part which rotates would continue, in the first case, to rotate in the same direction, while in the second case it would turn in the backward direction, both arriving at, or tending towards, a zero or pseudo zero point. It does not follow that retrogressive reversal would of necessity leave the sensitive substance in just the same state as it was before it had been affected by light. I shall probably return to this subject on another occasion.

Reversal in Shutter-Speed Tests.—My present intention was not to theorise on reversal, but to refer to a practical result of the Clayden effect; that is, reversal of the developable condition that has been produced by a short exposure to an intense light, by means of a subsequent comparatively long exposure to a feeble light, the latter not producing reversal when it precedes the former. In the use of Wynne's shutter-speed tester, a convex polished metal button moves in front of a graduated diagram, and it is photographed while the sun shines upon the whole arrangement. The length of the streak of light produced by the moving button indicates the period of the exposure. By moving upwards or downwards the pendulum that carries the bright button, several tests may be made on the same plate, if the camera is not moved. Under these circumstances the comparatively feeble light from the diagram produces its effect over the whole surface of the plate during each exposure, including those parts where the bright light from the button impinges on the plate, and this gives the superposed intense and feeble exposures which are liable to give reversal. I made seven tests on each of a few plates, and generally the first streak was reversed, the second and third were hardly discernible, the exposure effect from the bright button being incompletely reversed and the result neither one thing nor the other. I find that it is best to start with the longest exposure and to let the others (generally not more than three) follow. When giving 8, 6, $1\frac{1}{2}$, and $\frac{3}{4}$ hundredths of a second in the order stated there was no reversal. But 20, 3, 2, 1, and $\frac{3}{4}$ hundredths of a second gave reversal for $1\frac{1}{2}$ divisions and a feeble effort for the next 4 divisions (each division equivalent to the hundredth of a second) of the beginning of the first streak. The rest of the streak representing the first exposure, and all the others were represented by good black lines on the plate. With a series of 27, 11, 7, and 2 hundredths, $4\frac{1}{2}$ divisions at the beginning of the first were reversed, the next 10 were feeble, and the remainder good strong images. Thus the Clayden effect interferes sometimes in a very practical way under very common-place circumstances, and it is desirable to bear this in mind when giving multiple exposures, as is often done in experimental work. In the particular case referred to, if the sunlight were constant in its brilliancy, the streaks on the plate would all have practically the same exposure, the longer exposures simply giving longer streaks. But the length of the exposure would affect the general illumination of the plate by the surface of the diagram, and it seems that it is desirable to have as little as possible of this to *follow* or to be superposed upon the exposure effect due to the brilliant light reflected from the polished button.

Spirit Levels.—No camera intended for general work is complete without some means of showing when the sensitive surface is perpendicular, and in by far the greater number of cases a circular spirit level is the most convenient and effective apparatus for this purpose.



Messrs. Taylor, Taylor, and Hobson many years ago introduced the level shown in section, and were thereby successful in obviating the leakage which, before

then, was rarely avoided. The glass, B, is united to the cell, A, by the elastic ring, D, the whole being held together and protected by the outer casing E. They have now introduced a level made on exactly the same lines but with the flange for attachment to the camera at the upper part instead of the lower part of the body, so that the level, when fixed, presents a surface almost flush with the woodwork, as shown in the second

figure. These will be useful in cases where the others were impossible. There is one matter concerning the fixing of levels that is not always attended to, namely, that their sole use is to show when the plate is vertical. They must, therefore, be fixed to that part of the camera that carries the plate. If the back of the camera swings, the level must be attached to the back; it would be useless on the base-board, except only when the swing-back was not in use, and it was certain that the plate was perpendicular to the base-board.

Notes on the Return of Encke's Comet.

THIS comet will be favourably visible this year during the autumnal months. Perihelion will be reached on 1905, January 4, but it will probably be picked up in some of the large telescopes employed in cometary work in August and September next. Its nearest approach to the earth will occur in the third week of November, when its distance will be about 35 millions of miles.

On October 4 the position of the comet will be about midway between the stars β Andromedæ and α Trianguli. Moving westwards it will be found 5° N.E. of β Pegasi on November 1. Its apparent motion will increase, and in November and December be directed to S.W. Early in December the comet will be close to the brilliant star α Aquilæ (Altair). At about this period it will be easily visible in small telescopes, and may possibly be within reach of the naked eye.

This will form the 36th return of the comet (and the 29th *observed* apparition) since it was first discovered by Mechain in 1786. At intervals of 33 years (including 10 periods) the perihelion is reached at nearly the same time of the year as before, and in 1904 the favourable presentations of 1805, 1838, and 1871 will be repeated. In the three years last mentioned the comet was visible to the naked eye. Drawings of its physical aspect in 1871 appeared in *Monthly Notices*, XXXII, pp. 26 and 217, and *Astronomical Register*, X., p. 13.

The comet has been seen at every return since 1819. The following is a list of its perihelion passages, observers, and periods. The average duration of a revolution from 36 returns appears to be 1,206½ days. The nature of the orbit was determined from the observations in 1819.

Returns of Encke's Comet.

Perihelion.		Observer.	Detected		Period Days
* 1786 I. ..	Jan. 30	Mechain ..	1786	Jan. 17	
1795	Dec. 21	C. Herschel	1795	Nov. 7	1204 (3)
† 1805	Nov. 21	Thulis	1805	Oct. 19	1208 (3)
1819 I ..	Jan. 27	Pons	1818	Nov. 26	1204 (4)
1822 II ..	May 23	Rumker	1822	June 22	1212
1825 III. ..	Sept. 16	Valz	1825	July 13	1212
‡ 1829	Jan. 9	Struve	1828	Sept. 16	1211
1832 I. ..	May 3	Mossotti	1832	June 1	1210
§ 1835 II. ..	Aug. 26	Kreil	1835	July 22	1210
1838	Dec 19	Boguslawski ..	1838	Aug. 14	1211
1842 I. ..	April 12	Galle	1842	Feb. 8	1210
1845 IV ..	Aug. 9	Walker	1845	July 4	1214
1848 II. ..	Nov. 26	G. P. Bond ..	1848	Aug. 27	1205
1852 I ..	Mar 14	Hind	1852	Jan 9	1204
1855 IV. ..	July 1	Maclear	1855	July 13	1204
1858 VIII.	Oct. 18	Forster	1858	Aug 7	1205
1862 I. ..	Feb 6	Forster	1861	Sept. 28	1207
1865 II. ..	May 27	D'Arrest	1865	Jan. 25	1206
1868 III ..	Sept 14	Winnecke ..	1868	July 14	1206
1871 V. ..	Dec. 28	Winnecke ..	1871	Sept. 19	1200
1875 I. ..	April 13	Holden	1875	Jan. 26	1202
1878 II. ..	July 26	Tebbutt	1878	Aug. 5	1200
‖ 1881 VII.	Nov. 15	Hartwig	1881	Aug. 20	1208
1885 I ..	Mar. 7	Tempel	1884	Dec. 13	1208
1888 II. ..	June 28	Tebbutt	1888	July 8	1209
1891 III. ..	Oct. 17	Barnard	1891	Aug. 1	1207
1895 I. ..	Feb 5	Perrotin, Wolf	1894	Oct. 31	1206
1898 III ..	May 26	Grigg	1898	June 7	1207
1901 I. ..	Sept. 15	Wilson	1901	Aug. 5	1207
1905 I ..	Jan. 4 (¶)	—	—		1207

* Discovered near the star β Aquarii. Observed on two nights (Jan. 17 and 19) only.

† Independently discovered by Pons, Bouvard, and Huth, on Oct. 20, 1805. It had a tail ½° long.

‡ Distinctly visible to naked eye at end of November.

§ Boguslawski picked up the comet on July 30.

‖ Visible to the naked eye at Bristol in October.

¶ Computed date of perihelion passage.

There were seven unobserved returns to perihelion between 1786 and 1819, computed by Encke to have occurred as under:—

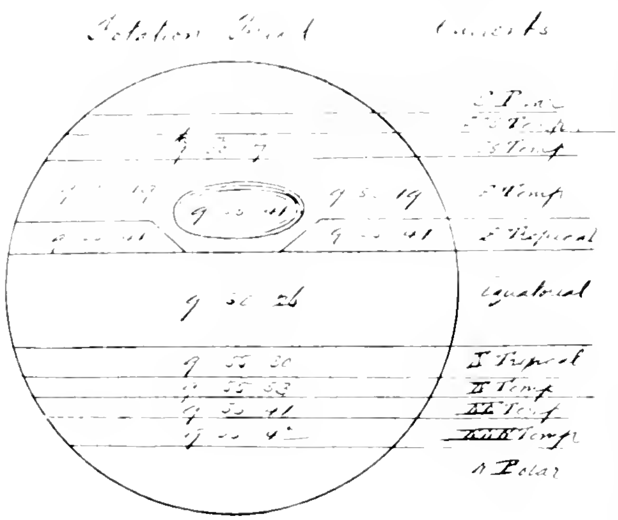
1789 May 19.
1792 September 4.
1799 April 11.
1802 August 2.
1809 March 12.
1812 June 26.
1815 October 13.

Encke found the period of the comet in 1789 to have been 1,212 days 19 hours. Seagrave, in *Popular Astronomy*, 1904, February, gives the present period as 1,206 days 20¼ hours, and says the time has decreased very nearly six days. This decrease would amount to about four hours per revolution. He gives an ephemeris for the coming return, but it has not been corrected for perturbations, and will, therefore, not accurately represent the path of the comet. No doubt Mr. Crommelin will supply a reliable ephemeris in later months. The comet, having a very interesting history as the first one known belonging to the Jovian family, as having suggested the idea of a resisting medium, and as having a smaller orbit than that of any other comet, should be followed by everyone possessing a telescope next autumn as it travels from Andromeda slowly through Pegasus and Aquila southwards to Capricornus.

W. F. DENNING.

Jupiter.

It is fortunate that in recent years Jupiter has been studied attentively at every opposition. The markings have been watched from the time when the planet rose about two hours before the sun to the time when he set about two hours after it. In fact, the observations have generally ranged over nine months of the year, and have been only



discontinued when Jupiter approached near the sun. Since 1898 we have gained a useful insight into the rates of motion of the various currents, and of the positions and changes of the belts. This continuous study of the Jovian surface must be maintained. It will ultimately prove of great value in elucidating the changes taking place in the velocity and aspect of the various spots, and it may be the means of revealing periodicity either as regards the motion or appearance of certain features.

In and since the year 1898, the writer, at Bristol, has found the rotation periods of the chief currents as under:

Year.	N. Temp	N. Trop.	Equa.	Red Spot	S Temp
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
1898	9 55 50.1	9 55 26.3	9 50 23.6	9 55 41.8	9 55 20.5
1899	„ „ 53.5	„ „ 25.8	„ „ 24.6	„ „ 41.9	„ „ 18.6
1900	..	„ „ 30.0	„ „ 24.1	„ „ 41.7	..
1901	„ „ 53.2	„ „ 31.6	„ „ 29.1	„ „ 40.9	„ „ 19.7
1902	„ „ 56.5	„ „ 29.8	„ „ 26.7	„ „ 39.0	„ „ 15.7
1903	„ „ 54.3	„ „ 31.9	„ „ 27.9	„ „ 41.6	„ „ 18.5

Somewhat similar observations and reductions have been made in recent years by Professor G. W. Hough, Captain Molesworth, Rev. T. E. R. Phillips, and Mr. A. S. Williams. When the work has further progressed through future years it will be important to compare all the accumulated materials to see whether some useful deductions cannot be made from them.

The mean periods of rotation from all observations in the table are: N. temp. spots = 9 h. 55 m. 53 s., N. trop. spots = 9 h. 55 m. 30 s., Equatorial spots = 9 h. 50 m. 26 s., Red spot = 9 h. 55 m. 41 s., S. temp. spots = 9 h. 55 m. 19 s. Thus the N. temp. spots move slower while the equatorial spots move quicker than any others observed in recent years. Of course, the most interesting object on the planet is the great red spot which for a long period has been so faint as to have scarcely merited that designation. But it was a little plainer during 1903 than in the few preceding years, and possibly it will be still darker during the present summer. The following are a few times when this marking will be on or very near the planet's central meridian. If the spot should not be visible the conspicuous hollow in the S. equatorial belt will show its position, and the time of transit of the latter object should be taken.

Date	Transit of Red Spot.
1904	h. m.
June 2	15 25
7	14 34
9	16 12
14	15 21
19	14 29
21	16 8
24	13 38
26	15 16

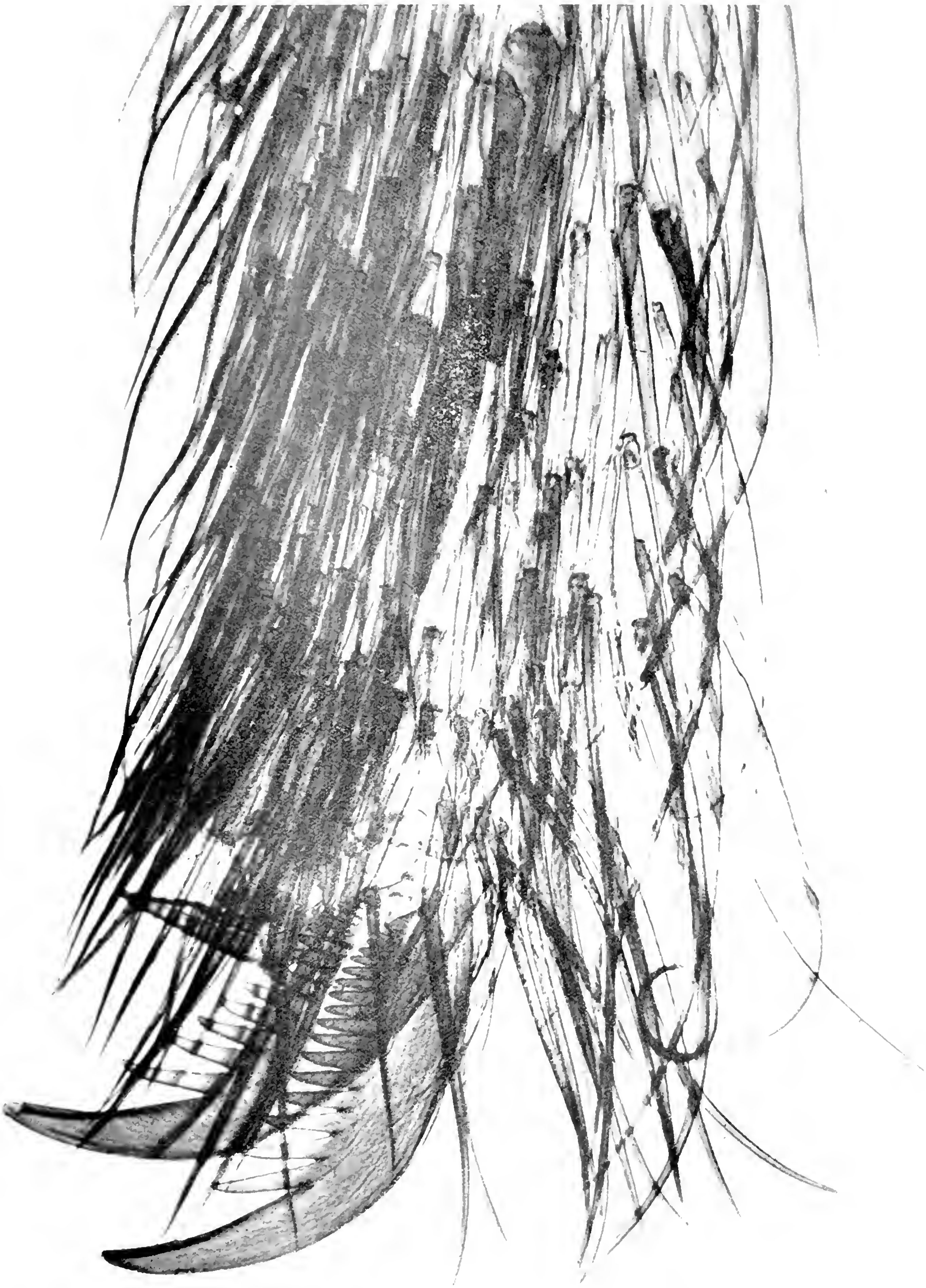
To the various other markings particular reference need not be made. In recent years they have, however, been very numerous, and many of them conspicuous. Any spots which may appear near the poles of the planet should be watched with great attention.

W. F. DENNING.

The Leg and Foot of a Spider.

At the conversazione of the Royal Society this photo-micrograph, which forms our full-page illustration, was shown, with many others. The aim of the exhibitors, Messrs. Arthur E. Smith and Richard Kerr, was to point out the value of direct photography on to a 12 by 10 inch plate and to show its advantages over enlargements made from smaller negatives. The details obtained at once by combining an unusually large camera with a monocular microscope are greater than those secured by ordinary amplifying methods. This illustration represents an enlargement of 260 diameters and has been obtained by a one-inch objective and a focal length of 37 inches approximately. The negative has received no touching up whatever.

The expeditions at present afloat and organising for discoveries in the North Pole regions, as summarised by the *American Inventor*, are (1) that of the Russian Baron E. Toll, who left the island of Kotelnoi, in the New Siberian group, over a year ago, and has not since been heard from; (2) the new Ziegler expedition, commanded by Captain John Haven, which left New York last spring, reached Tromsoe near the end of July, and upon attempting to make Franz-Josef Land met with obstacles which have deferred further attempt till next spring; (3) an expedition projected by Captain Drake, who will sail for Vladivostok and Point Barrow in Alaska, whence he will later make a "dash for the Pole"; and (4) Lieutenant Peary's new venture, which was announced in the early part of September. The Norwegian Amundsen is supposed to be among the islands of British North America, in search of the magnetic pole.



The Leg and Foot of a Spider.

The Solar Atmosphere at Different Levels.

By E. WALTER MAUNDER, F.R.A.S.

IN "KNOWLEDGE" for October, 1903, we published a fine photograph of the sun in K-line, taken on April 27, 1903, with the Rumford spectroheliograph attached to the great 40-inch refractor of the Yerkes Observatory, by Professor George E. Hale and Mr. Ferdinand Ellerman. This spectroheliograph, a photograph of which was given in the same number, has a train of two prisms of 60°, set at minimum deviation for the K-line. The collimator and camera lenses are of the portrait lens type by Voigtlander with apertures of 6¼ inches. They are of equal aperture and focal length (33 inches), and may be focussed singly or together by means of a rod connecting the pinions which move each lens in its tube. The tubes of collimator and camera are parallel to each other, the light from the collimator being reflected from a plane mirror on to the first surface of the prism train. If required, a much higher dispersion can be obtained by substituting a grating, ruled with twenty thousand lines to the inch, for the above mirror, the first order spectrum being employed. The second slit of the instrument is, of course, placed close to the focus of the camera lens, and the great 40-inch telescope is made to move slowly in declination by means of a slow motion electric motor, the sun's image consequently moving at a uniform rate across the first slit, whilst the photographic plate is at the same time driven at the same rate across the second slit by means of a shaft led down the tube of the telescope from the motor. The motion of the focal image of the sun, produced by the motor, is about one minute of arc in four seconds, when one set of gears is employed, and in twenty-four seconds when another. The two slits are each 8 inches in length, and are given the proper curvature necessary to eliminate the distortion of the solar image. But, as the focal length of the great refractor is 64 feet, and the image of the sun in the principal focus is consequently a little over 7 inches in diameter, the aperture of the spectroheliograph is not quite sufficient for a full image of the sun, and occasioned the falling off in brightness at the two opposite limbs of the sun, noticed in the plate published in "KNOWLEDGE," opposite p. 229 in the last volume.

At that time Professor Hale wrote:—"By setting the second slit on various parts of the K-band it is possible to photograph sections of the calcium flocculi at different elevations above the photosphere. This is due to the fact that the width of the K-band is determined by the density of the vapour; hence, if the slit is set near the outer edge of the broad band, it can receive light only from the calcium vapour, which is dense enough to produce a band of this width. When the slit is set near the centre of the band it receives light from all the vapour lying below the corresponding level. But as the vapour expands as it rises, a given photograph always shows the structure corresponding to the lowest density (highest level) of the calcium vapour competent to produce a line of the necessary width. I shall publish very soon a series of photographs showing how spots are successively covered by overhanging calcium clouds in photographs taken at different levels."

This promise has been fulfilled in the recently published Memoir on the Rumford Spectroheliograph which forms Vol. III., Part I., of the Publications of the Yerkes Observatory, from which we are enabled to reproduce four photographs out of the great number by which the Memoir is illustrated. The four chosen, Figs. 1 to 4, represent the great spot group of 1903, October 9, as photographed with the slit placed in three different positions on the H-line of calcium and upon the centre of the F-line of hydrogen.

In the last number of "KNOWLEDGE," we reproduced a portion of one of M. Janssen's superb photographs of the solar surface, showing in a very distinct manner the curious structure which it presents. The minute granulation which the disk thus either shows to the eye under the most perfect conditions of seeing, or reveals to the photographic plate when the precautions taken

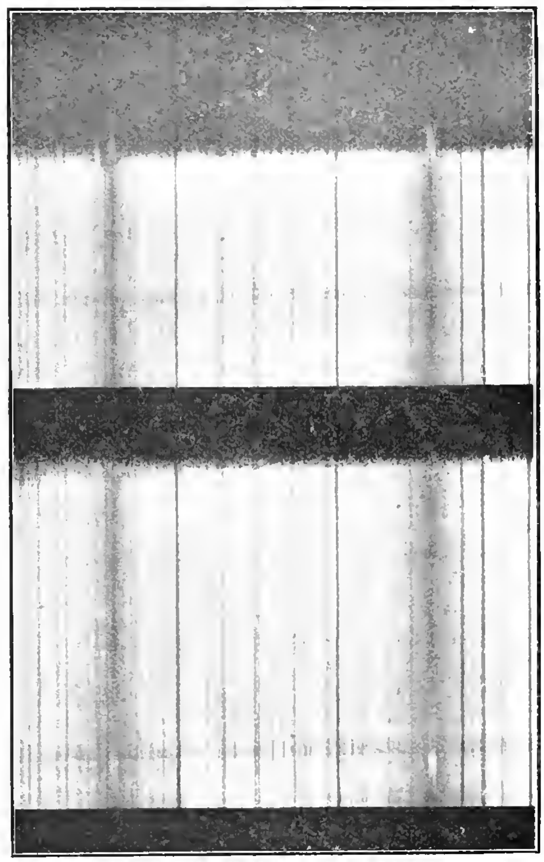


Fig. 5. H and K lines on the Disk, in the Chromosphere, and in a Prominence (a).

by M. Janssen are employed, has its parallel also in the structure shown by the calcium "flocculi" (to adopt the word suggested by Professor Hale, and generally accepted), revealed by the spectroheliograph. From the greater difficulties of the work the granulation shown by the flocculi is not in general so minute as that shown on Janssen's photographs, and in many cases their granules appear to have run together to form the great fleecy clouds so conspicuous in the photograph reproduced in October of last year. Professor Hale, on the working hypothesis which he at present employs, considered the minute floccular granules as columns of calcium vapour, rising above the columns of condensed vapours of which photospheric granules are the summits. The question arose whether these larger calcium clouds were made up of similar columns of

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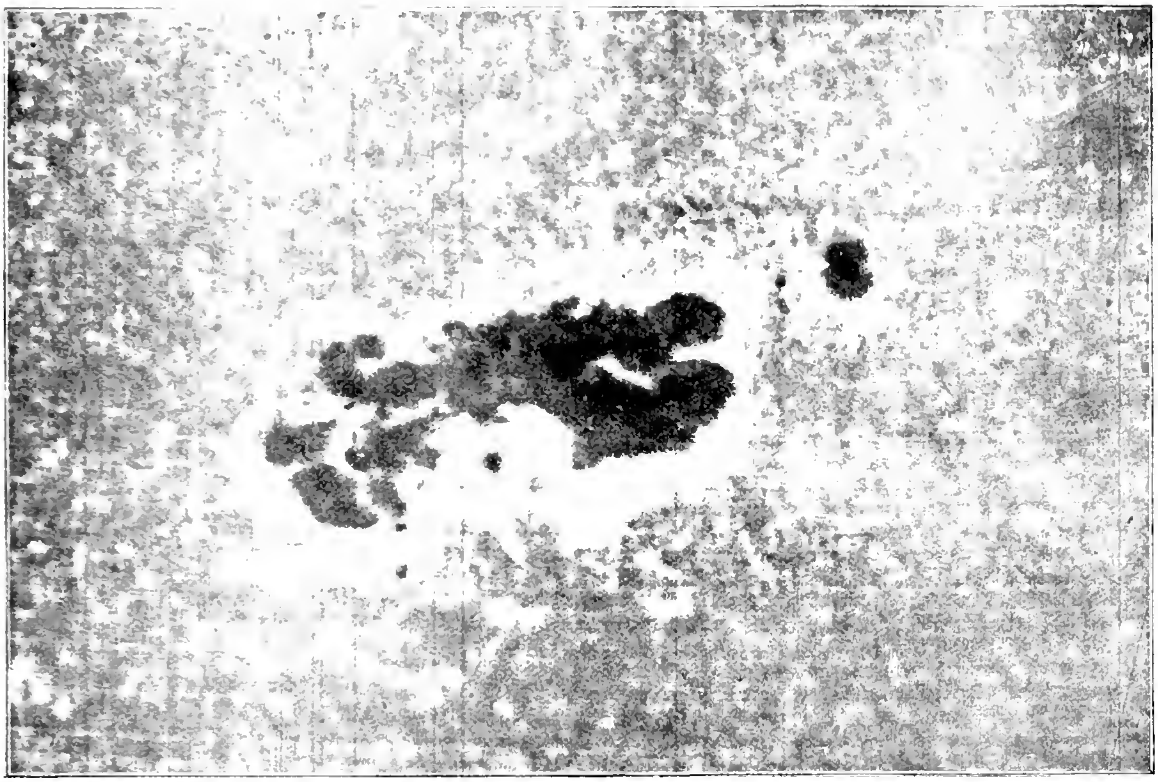
E  W

Fig. 1.—1903 October, 9d., 3h., 42m. Calcium Flocculi, Low H_1 Level.

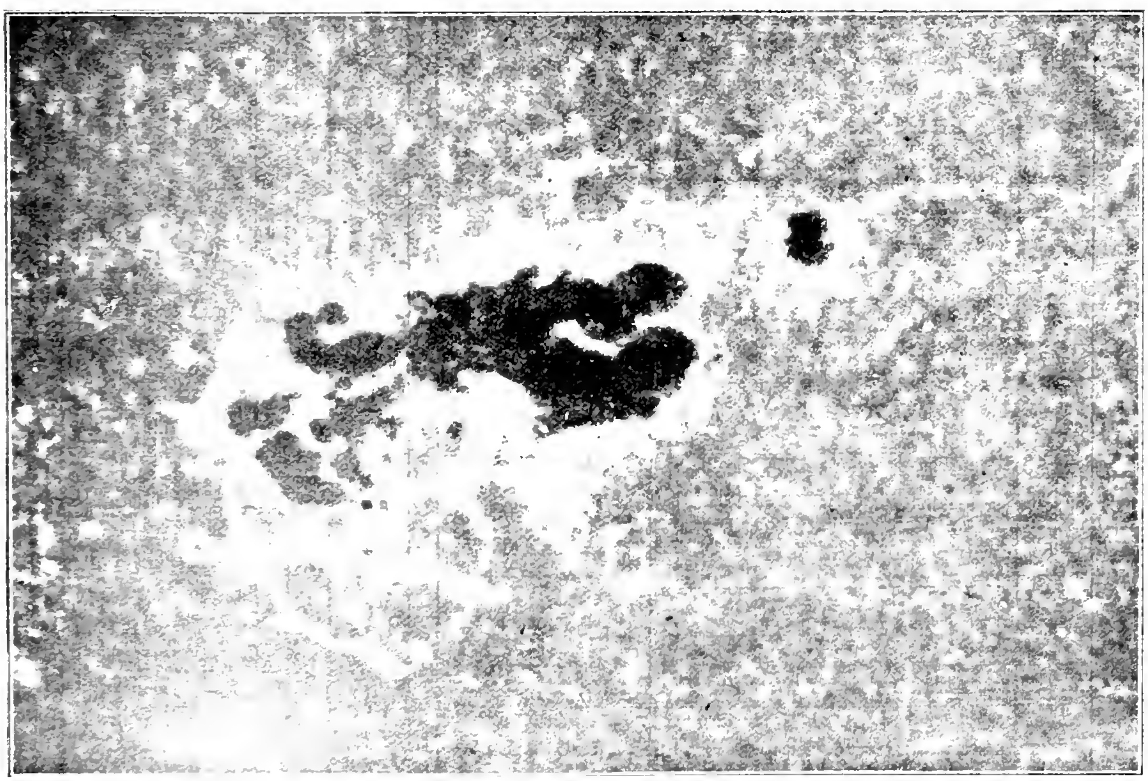
E  W

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Fig. 2.—1903—October, 9d., 3h., 43m. Calcium Flocculi, Middle H_1 Level.

THE GREAT SUNSPOT OF 1903 OCTOBER.

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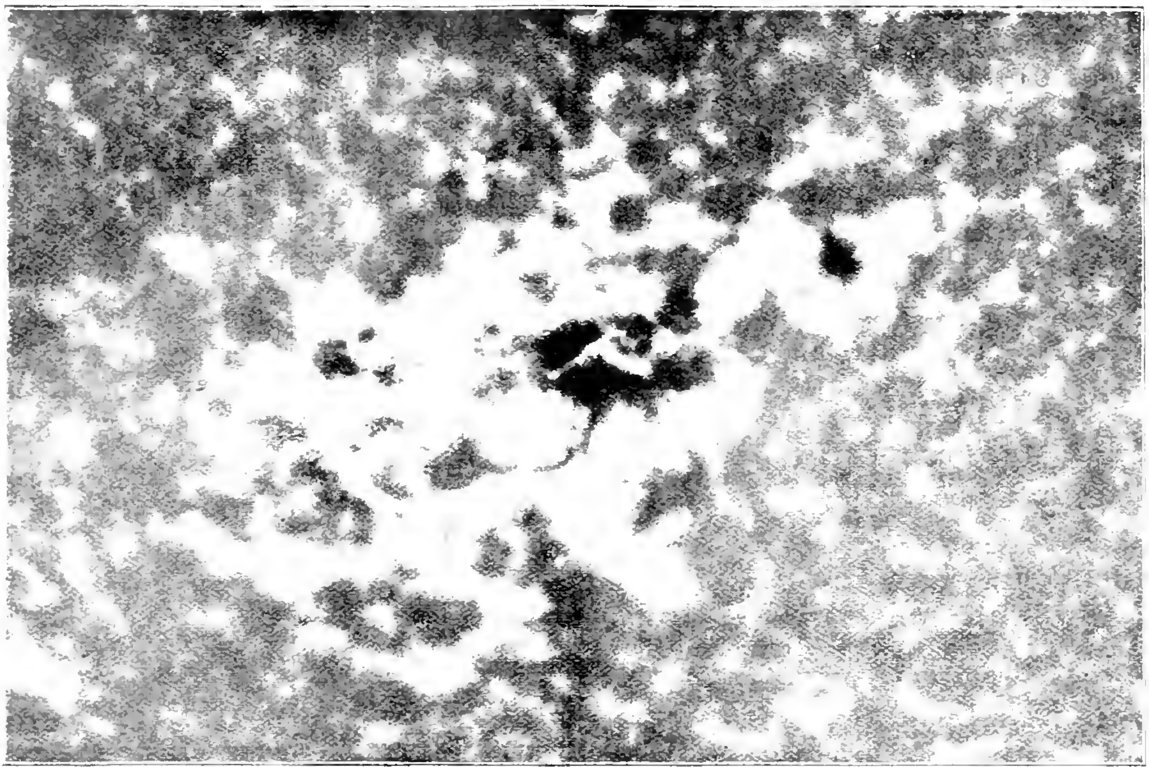

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Fig. 3. 1903 October, 9 d., 3 h., 30 m. Calcium Flocculi, H Level.

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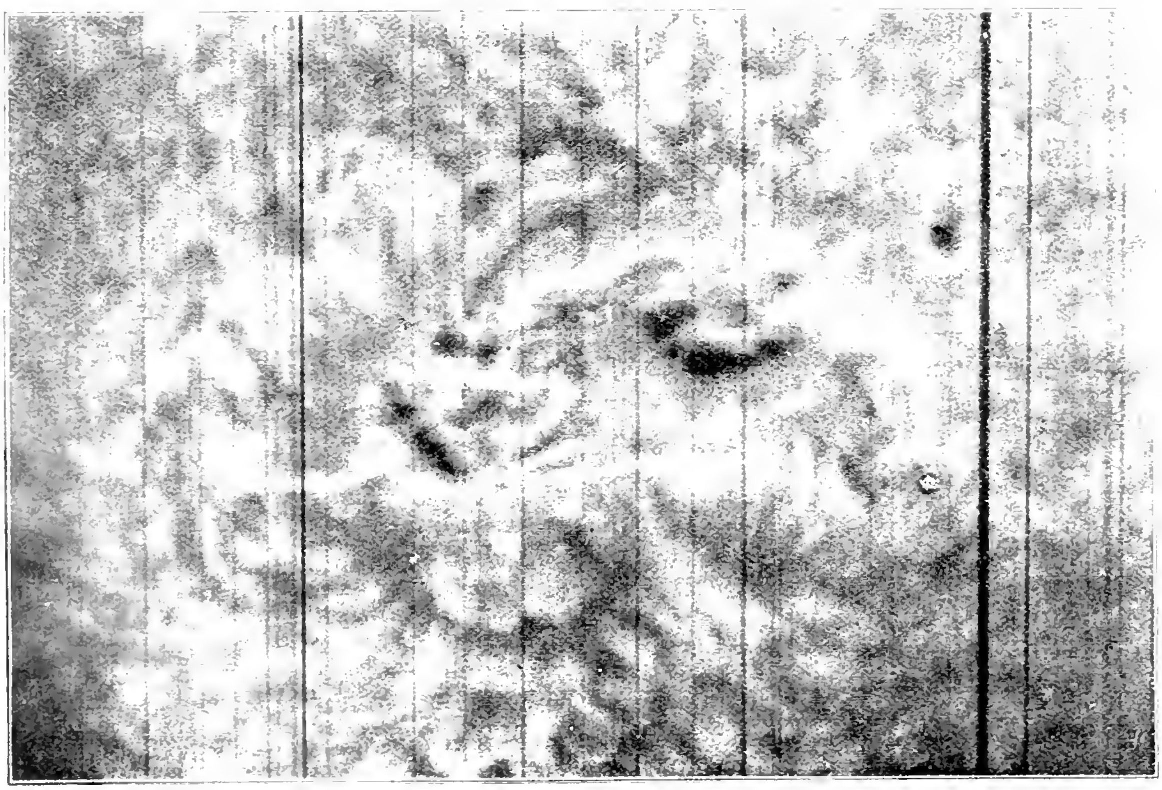

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Fig. 4.—1903 October, 9 d., 1 h., 4 m. Hydrogen Flocculi.

THE GREAT SUNSPOT OF 1903—OCTOBER.

calcium vapour, and the method by which Professor Hale endeavoured to answer this question is one of great ingenuity and interest.

Referring to Fig. 5, which is extracted from one of the plates of the same Memoir, the H and K lines are there seen as photographed on the disk in the chromosphere and in a prominence. Upon the disk the H and K lines are seen as usual as broad and diffuse bands. These, in the chromosphere, are replaced by bright lines which are fairly defined. At the top of the figure, in a prominence, these bright lines thin out into very much narrower lines, changes which correspond to the different phases of the bright lines of calcium, obtained when a considerable quantity of calcium vapour is introduced into an electric arc. Under these circumstances, broad bands, bright in the centre and fading towards both edges, appear in the places of H and K. The width of these bands decreases towards the outer part of the arc where the calcium vapour is least dense and relatively cool; whilst in the centre of the broadest part of the bands a thin dark line is seen, due to the absorption of this cooler rarer vapour in the outer part of the arc. So it is no doubt with the calcium vapour surrounding the sun. The darkness of the calcium bands, H and K, would be due to the calcium vapour being cooler than the photosphere below it, whilst their breadth would indicate that in this lowest stratum it is of considerable density. Higher up, as we see in the behaviour of the bright H and K lines at the limb, the density of the vapour is diminished, and the lines are fairly well defined. For distinctness of reference, Professor Hale denotes the broad diffused bands as H_1 and K_1, whilst the narrower lines he calls H_2 and K_2; the very thin lines seen in the upper chromosphere and prominences being H_3 and K_3. It will be noticed, on examination of the calcium lines on the disk, that at times we have a bright H_2 or K_2 line, superposed on the broad dark band H_1 or K_1 whilst this bright line is bisected again by the extremely narrow dark line H_3 or K_3.

The explanation of the principle upon which Professor Hale works will now be evident. If the second slit be placed at the edge, say of the K_1 line, it is manifest that only that calcium vapour which is sufficiently dense to produce a line broad enough to reach the slit can act on the photographic plate. The upper rarer strata of calcium vapour, giving lines of smaller breadth, will lie outside the slit, and their light will therefore be screened from the plate. Under these circumstances the photograph obtained is virtually that of the lowest stratum of calcium vapour. If the slit be set nearer to the centre of the line, but not at the centre, it is clear that, as before, the highest strata giving lines too narrow to enter the slit will be shut out from recording their presence. But it may be urged that it might nevertheless include regions lying below it where the calcium vapour is dense enough to produce a broader line. However, as Professor Hale puts it, "Since the calcium vapour is rising from a region of high pressure to one of much lower pressure, it must expand as it rises, and therefore a section at any level should, in general, be of a larger area than a section of the same flocculus at any lower level. As a consequence of the increasing extent of the vapour with the altitude, and the increase of brightness observed when passing from K_1 to K_2 a photograph corresponding to a given level is not necessarily affected in any considerable degree by the existence of the denser vapour below, except in cases where the high-level vapour does not lie immediately above the low-level vapour." Broadly speaking, therefore, and not using the term "level" in too precise a sense of altitude, it would seem that this ingenious method does give us a view of the distribution of the more or less heated columns of calcium vapour at various levels above the surface of the sun.

The first three photographs in the accompanying plates show the well known great spot of last October 9 as photographed with the slit at different positions on the great H-line. Fig. 6 in the text gives the same spot as photographed in the ordinary manner. In all three of the calcium photographs some of the salient features of the great spot group can be detected. The little nearly circular herald spot, the heavy compact form of the preceding half of the great group, the sinuous bridge which traverses it from west to east, and the more complex structure of the following half of the group, can be made out at each of the three "levels." But whilst the bright flocculent matter is quite restricted in area and granular in character in the first photograph, it increases in brightness and becomes much more coherent in character, extending over a much wider area as we proceed from the first to the second photograph, and again from the second to the third. Indeed, the bright clouds of the third photograph all but hide the great sunspot from view. The three pictures taken together

Fig. 6. The Great Sunspot of 1903, October 9. Photographed with the Greenwich Photoheliograph.

seem to afford, therefore, clear indications of the expanding of the vapours as they rise.

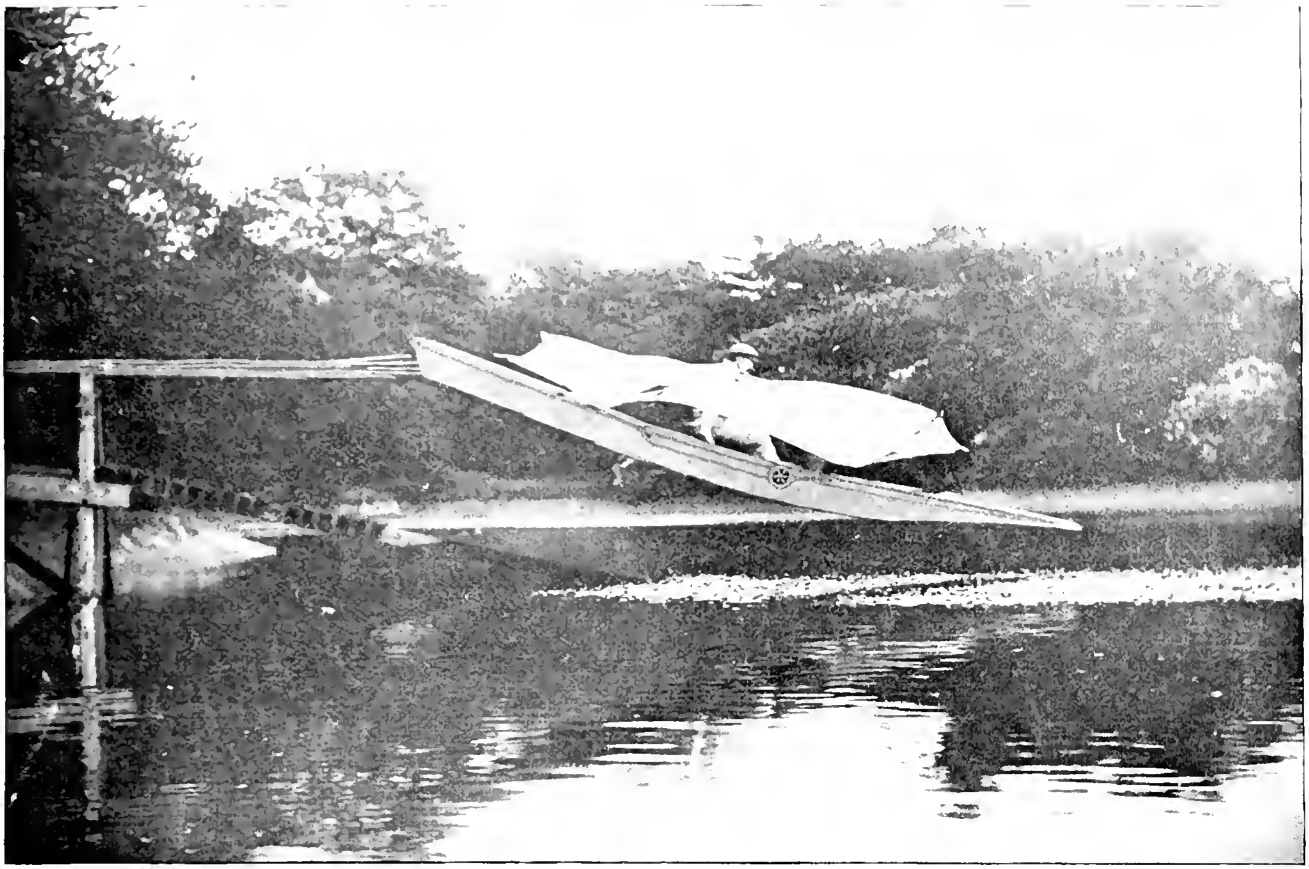
The fourth photograph (Fig. 4), representing the same area of the sun, differs from them totally in appearance. This was taken on the F-line of hydrogen. The little pioneer spot can still be identified, and some portions of the umbra of the great spot that followed it. But the spot as a whole is hardly recognisable, although its outline is not concealed by spreading masses of bright clouds as in the third calcium photograph. Indeed, not a few of the bright structures seen in the calcium photographs are here represented by dark forms. The character, too, of these forms differs; the hydrogen structures suggesting storm and stress, whilst those of calcium rather are appropriate to the processes of quiet precipitation. It should, however, be borne in mind that, whereas on the explanation here given, in the calcium photographs we are dealing with quite restricted strata of the sun's atmosphere, the hydrogen photograph gives us the summation of the effects of many strata. For as the *hydrogen* line is much narrower than the two giant lines of calcium, it is not possible to isolate small portions of it in the same way.

Aeroplane Experiments.

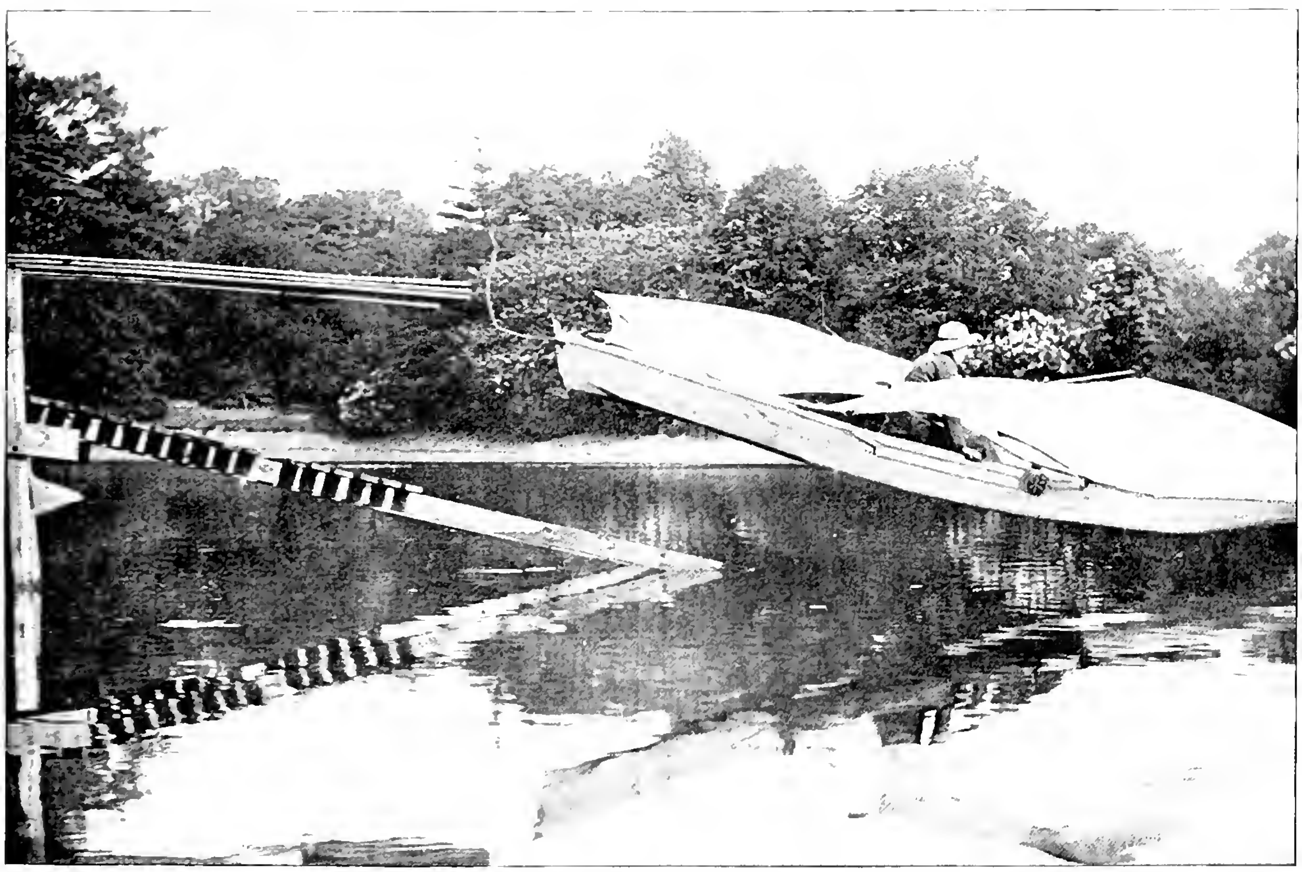
By Major B. Baden-Powell.

In the last number of "Knowledge & Scientific News" was described the apparatus which I have erected at the Crystal Palace for giving initial impulse to a man-carrying aeroplane in order to test the balance and steering arrangements. Since this account appeared many more experiments have been conducted, although we have learnt what a vast amount of small details need alteration and adjustment before good results can be obtained. Repeated trials showed that the boat sliding down between the inclined rails did not nearly attain the speed which it should have accomplished according to theory, and it was only after many days that one cause of this was discovered. Although the gauge of the track had been carefully tested on completion, and though the inside of the rails appeared to be perfectly straight, a subsequent measurement of the gauge, after the structure had been subjected to many days' alternate sunshine and rain, proved that the wood had swollen and warped so that there was a slight contraction about half way down. This was just sufficient to cause the boat, in its descent, to become slightly jammed between the rails, but not sufficient to stop its way, so that to all appearances the apparatus simply ran very slowly. This difficulty was, of course, soon overcome by planing away about ¼ inch from the inside of the rails. Then various trials with different forms of lubrication for the runners showed difficulties with this method, and resulted in the application of small wheels to the sides of the boat in place of the oak runners. The track itself was also altered, as it was found that the "take off" at the lower end was rather too steeply inclined and detracted from the speed. On June 8 the first trials were made with a man in the boat, and several fairly successful descents were made, both by Mr. J. T. C. Moore Brabazon (who has kindly given me most valuable assistance in these trials) and by myself. The size of the aeroplanes used on this occasion was insufficient to make a good glide, the total weight of the apparatus amounting to some 270 lbs., and the area of the aeroplanes (each 12 ft. by 5 ft. 6 ins.) to only 132 square feet. It was considered desirable to try the apparatus with this small aeroplane, with the object of testing the strength of all parts, and in this respect the results were most satisfactory. The boat, consisting of rough boards and battens screwed and nailed together, covered with canvas, stood a lot of very rough usage, and scarcely suffered at all from its plunges into the water. The aeroplanes were of thin cambric, stretched on bamboos of about 1½ ins. diameter at the butt ends. These were fixed to the boat, but otherwise not stayed or trussed in any way; and though they bent upwards considerably during the descent through the air, proved to be amply

Ready to Start. *Photo by Russell.*



In Mid Air. [Photo. by Russell.



Another Glide. Photo. by Russell.

strong enough for the work. By constructing the wings on this principle, instead of so staying them as to be rigidly horizontal, an advantage was gained in that while on the track the ends were not caught by any side wind, and yet, while supported in the air, a considerable diedral angle was formed which gave the desired transverse stability. On June 13, some larger aeroplanes were fitted. These were of hexagonal shape (being, in fact, constructed of old man-lifting kites), and were each of 118 square feet area. The arrangement may be seen in the last photograph. The lower end of the track had now been altered by removing the end support so as to allow the ends to droop. This is shown in the two photographs of the apparatus in the air, the boards having sprung back into the horizontal position after having been depressed by the weight of the boat. As the boat left the track, it was canted forward so that it shot downwards into the water too abruptly to make a good glide. There was, moreover, on this occasion a considerable head wind, which often interfered to some extent with the apparatus attaining a good speed, but which was not found to be so serious as might be thought. The usual time of descent from the top of the track to the take-off was just 3 seconds, being sometimes extended to $3\frac{1}{2}$ seconds. On June 18 further trials were made, after a number of minor improvements had been effected. The lower end of the track was now rigidly supported and set so as to be exactly horizontal. A triangular "beak" of 18 square feet was spread in front of the same hexagonal aeroplanes, and some fairly successful glides were made, although, of course, the weight per area (1·24 lbs. per square foot) was still very excessive when compared to the proportions which previous experimenters with aeroplanes have applied.

Now that the general arrangement and practical working of the apparatus has been well tested, it will be possible to make more exact trials. It is proposed to fit on an upper aeroplane and other additions to make the total supporting surface up to some 430 square feet, and it then seems probable that we may be able to make some useful glides, full accounts of which I hope to send in for the next number.

Paddling Ashore After Descent. [Photo by Russell.

CHICAGO is considering a new machine to mend the holes which all too frequently make their appearance in asphalt streets. A committee has gone to Pittsburg from Chicago to test the device, and if it proves to be able to do what is claimed for it, it will probably be adopted in other cities besides Chicago. Asphalt mending as it is done at present is both a tedious and expensive job, and a machine which would do good work automatically would find a ready field.

Electrical Ore Finding.

Prospecting by Telephone.

IN the early part of June, Professor Silvanus Thompson, F.R.S., delivered a kind of informal lecture on the Daft-Williams method of locating metalliferous deposits by means of electricity; and the system, which has been the subject of investigation for some time, may now be regarded as having passed from the uncertainty of experiment into the sphere of practical usefulness. Its usefulness has some limitations, some of which Professor

The Apparatus. *Photo by Burrows.*

Silvanus Thompson indicated. It depends for its success on the difference in electrical conductivity displayed between the lode of metal which it is desired to locate and the soil in which the lode is found. Therefore, although the system has been undeniably successful in locating veins of galena and of zinc blende, it does not follow that its success would be equally marked in locating other metals existing in other matrices; and it is by no means certain that the results could distinguish between a small thickness of rich ore and a number of stringers containing an equal amount of ore so distributed as to be commercially worthless. Still, the system is capable of showing great development; it is at present by no means a mere scientific curiosity; and even if it were, it is well worth attention.

We may best begin its description by an illustration. If a flow of electricity were to take place between two points at the top and bottom of this page, the electric flow would not take place in a single straight line, but would arrange itself in a number of lines with a greater or less resemblance to the lines of force between the poles of a magnet. But if on the page a bar of metal were laid, then the position of these lines would be disturbed—as a log in a pond would disturb the concentric ripples that a stone thrown into the pond's middle would otherwise produce. Similarly, if we cause a current to flow between two points on the earth's surface, a field of force in the earth's crust is formed; and, as Sir William Preece showed some twenty years ago, the lines of flow of the field can be studied with a telephone circuit connected to earth by portable electrodes. In Messrs. Williams and Daft's apparatus, the two transmitting electrodes (between which the current is to be sent) are earthed usually about 100 yards apart. The circuit in which they are the two points is fed by an induction coil which can deliver a very heavy secondary discharge into

Photo by Burrows.
Listening to the Telephonic Communicators.

a glass condenser. Two spark gaps—in series and in parallel—are inserted in the circuit. The breaks are of two types; one of the pendulum type, and one which is designed to give a "make" of any desired length and a break of unusual abruptness. The receiving (or telephone) circuit, which is to explore the lines of force created, consists of two telephone receivers, each of 500 to 900 ohms resistance, connecting to the exploring electrodes through a series of parallel switch.

While the current passing between the transmitting electrodes is suffering its "make and break," the telephones attached to the other or receiving electrodes, which are immersed in the soil about seventy feet apart, enable the investigator to "hear" the current as it passes. It sounds in the telephone receiver like the tap of a woodpecker, and it can be heard even when the two telephone electrodes are immersed in the earth several miles away from the immersed transmitting electrodes. In practice, it is not usual to explore at distances more than half a

mile away from the transmitting electrodes. If the field is entirely uniform, then the telephones will show, by the sounds of the tapping in them, that the direction of the lines of flow of the current is approximately in accordance with the theoretical diagrams as shown in text books.

Now we come to the question of the variations from the normal, caused by underground deposits of metalliferous bodies. Lodes are electrically divided into two classes, those which are better conductors than the enclosing rock, and those which are, comparatively speaking, insulators. A good conducting lode changes the shape and intensity of the normal field in a remarkable manner—elongating it in the direction of the strike. Waves passing into the lode at great depths are brought up to the surface. Hence, over the apex of the lode there is a concentration of energy and a corresponding increase of the sounds in the telephones when in the neighbourhood of the lode. In this way the position of the lode is easily ascertained, and, on exploring with the receiving electrodes further and further away, no sounds are heard whatever, except over the path of the lode. By moving the electrodes, a point is found where the sound suddenly ceases in some cases, but is again audible on moving the electrodes a little further. This point of equipotential and consequent silence occurs when the electrodes are so placed that the apex of the lode is midway between them. Absolute silence is not invariably attained, but in the case of conducting lodes, a diminution of sound always occurs. If the operator is nearer to the transmitting base and is receiving some of the normal waves which are travelling on and near the surface at an angle to the direction of the lode's strike a cross field is observed when the lode is between the electrodes, and the telephones give broken and discordant sounds. With lodes which act as insulating bodies, the field is never elongated, but possesses its normal shape. The waves, on encountering the lode, are brought to the surface of the ground on account of their inability to pass through, and, consequently, are all concentrated in the space between the apex of the lode and the earth's surface. When the telephone electrodes—being moved across the field at right angles to the direction in which it is expected the ore bodies strike—arrive at a point over a lode of this kind the increase in sound is sudden and intense, as might be expected when we consider the great depths from which the insulating body causes the waves to be brought.

There are many other ways of examining and testing the lie of veins and lodes; and the skilled investigator is able, by a suitable restriction of the electric field and by adjustment of the potential of the transmitting current, to apply tests for the depth of the lode. Much has probably yet to be done in elaborating the possibilities of this method, and in simplifying or codifying its applications, so as to render it accessible in ordinary use; but of its use and of its interest no doubt need be entertained.

THE Japanese explosive, Shimose, has been said to be more powerful than either dynamite or guncotton. Shimose does not explode on percussion, or by fire, and is not injured by wetting. When it is exploded, by a charge of fulminite, it tears a hole greater than would result from the use of a similar quantity of dynamite, and, unlike that substance, its force is equally exerted in all directions.

NOTES

ASTRONOMICAL.

The Solar Parallax.

AT the last meeting of the Royal Astronomical Society on June 10, Mr. A. R. Hinks read a paper on the determination of the Solar parallax from the measurement of photographs of the minor planet Eros, taken at the Cambridge Observatory, and at several other co-operating observatories. The value obtained agreed very closely indeed with that secured several years ago by Sir David Gill from observations of the three minor planets Victoria, Iris, and Sappho: Mr. Hinks getting 8″·706, as against Sir David Gill's 8″·802. At the Académie des Sciences of Paris on June 6, M. Bouquet de la Grye gave the result of the measurement of the photographs of the transit of Venus, 1882, obtained by the French expeditions. These gave values varying from 8″·786 to 8″·702.

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An Interesting Variable Star.

Number 6700 of Chandler's Catalogue of Variable Stars is a 4th magnitude star, bearing the name of Kappa Pavonis. Its variability was discovered by Dr. Thome in 1871, and it has been the subject of a very careful scrutiny during the last thirteen years by Dr. A. W. Roberts, of Lovedale, South Africa. The period of variation is about nine days, and the range from magnitude 4 to magnitude 5·5. The period of increase is slightly shorter than the period of decline—M − m = 4·71 days, whilst m − M = 4·38 days; but when all the observations are brought together and compared with the ephemeris, it is seen at once that there is a small systematic variation in the length of the period—a variation which goes through all its phases in the course of eight years. This would be explained if we regarded the variable as travelling in an orbit seventy times as large as that of the earth, in a period of eight years, implying that it was revolving round an invisible primary of a mass 5000 times as great as that of the sun. It is, of course, possible that this secular variation may be accounted for in other ways, and may even be purely observational in character; but it suggests that the star should make a very promising subject for the most careful heliometer and spectroscopic observations.

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The Stars of Secchi's Third Type.

The distinguishing feature of the spectra of these stars—"Antarian" stars, as Sir Norman Lockyer calls them, after one of the brightest examples of the type—is the system of seemingly dark flutings, sharp towards the violet, and shading off towards the red end of the spectrum. Until quite recently the origin of these flutings has remained without any satisfactory explanation, and indeed, the question has been debated as to whether the spectrum should not be regarded as one consisting partly of bright flutings fading towards the violet, rather than as one consisting wholly of absorption flutings fading towards the red. Professor A. Fowler, of the Royal College of Science, South Kensington, in a paper recently communicated to the Royal Society, appears to have given a satisfactory solution to this long-standing problem. He finds that the flutings are truly absorption effects, and that they correspond within the possible limits of error with the flutings of titanium. The flutings in question come out in the arc spectrum, if a liberal supply of titanium oxide be used with a very long arc. As yet Professor Fowler has not been able to decide completely whether the flutings are due to the vapour of titanium itself or to that of its oxide. It is interesting to note, especially in view of the correspondences which Professor Hale has found in stars of the fourth type to the lines typical of the spectra of sunspots, that Miss Clerke last year, in her book "Problems in Astrophysics," definitely

suggested the enquiry as to the presence of titanium and its usual associate, vanadium, in stars of the third type on account of the importance of those two elements in sun-spot spectra.

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The Fifth Satellite of Jupiter.

Miss E. E. Dobbin, whilst a student at the Yerkes Observatory in the summer of 1902, undertook, at the request of Professor Barnard, an investigation of the relative worth of the orbits deduced for the fifth satellite of Jupiter by Dr. Cohn and M. Tisserand. Later, she undertook a complete discussion of the problem, using only the observations of Professor Barnard, in order to secure greater homogeneity. The observations ranged from 1892 to 1903 inclusive, and her discussion gives the following elements of the orbit:

(*a*) = 47″·961
(*e*) = 0·00308
*d*P = 2°·429 daily, or 887°·20 yearly.
π = 227°·10, *l* = 103°·89
n = 722°·6316 daily

The most noticeable feature of these results is the smallness of the eccentricity as compared with that obtained by Dr. Cohn and M. Tisserand. Miss Dobbin is doubtful whether the change is real, and denotes a progressive perturbation which will end in reducing the ellipse to a perfect circle, or is an accidental one, and the question can only be decided after another decade of observation or more. The satellite was noted to be ahead of its ephemeris place in 1902 and 1903. This was due to the initial value of the longitude of the node being too small by 0°·7, or 1°·4, by which amount the orbit should be moved forward.

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Orbit and Spectrum of Delta Orionis.

About four years ago M. Deslandres found that Delta Orionis varied in its velocity in the line of sight, or, to use a shorter phrase suggested by Dr. Hartmann, was an "oscillating" star. M. Deslandres deduced a period for it of 1·92 days, and a very eccentric orbit. The star was then placed on the observing list at Potsdam, and Dr. Hartmann, having obtained more than 40 plates of its spectrum, has carried out a new discussion of its orbit; for which he finds the period, 5 days 17 hours 34 minutes 48 seconds ± 17 seconds, and an eccentricity, 0·10334. In other words, the orbit is nearly circular. But the striking discovery lies here: whilst the lines in general are characteristically hazy, and show periodical displacements, one line, the K line of calcium, though always exceedingly weak, is always narrow and sharp, *and takes no part in the periodic displacement shown by the other lines.* Dr. Hartmann concludes that this K line cannot be due to the spectrum of the fainter component of the star, but that a cloud of calcium vapour must lie between us and Delta Orionis, producing this absorption. An analogous phenomenon was displayed by Nova Persei at one time in 1901, and Dr. Hartmann notes that the component of the solar motion for both Delta Orionis and Nova Persei almost exactly corresponds to the velocity indicated by these stable calcium lines, implying that in both cases the intervening calcium clouds are almost completely at rest relatively to the stars from which the elements of the sun's way have been computed. The distance from us of this cloud cannot be determined, but its extent might possibly be ascertained by observations of the K line in neighbouring stars.

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Sunspot Variation in Latitude.

An interesting discussion took place at the last meeting of the Astronomical Society on June 10 on the above subject. Dr. W. J. S. Lockyer recently communicated a paper to the Royal Society, stating that "Spörer's Law of Spot Zones was only approximately true. Spörer's curves being the integrated result of two, three, and sometimes four 'spot activity track' curves, each of the latter falling nearly continuously in latitude." The Rev. A. L. Cortie and Mr. Maunder both read papers on the same subject, the former showing that the limiting latitudes for large sunspots rose from minimum to maximum instead of falling in the manner described by Dr. Lockyer, and that the "spot activity tracks" of which he spoke had no real existence. Mr. Maunder showed that the Greenwich Sunspot Results for the last thirty years fully confirmed Spörer's Law, and proved that there was but one general zone of spot activity in each hemisphere. When every separate spot group was plotted down according to its solar latitude, it was seen at once that there were no such separate downward moving "spot activity tracks" as Dr. Lockyer had described.

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The Royal Observatory, Greenwich.

The annual report of the Astronomer Royal to the Board of Visitors was read on Saturday, June 4. The year's record had been destitute of sensational incidents, the most noteworthy being the great magnetic storm of October 31-November 1. But the report records the completion, or near approach to completion, of a number of most important enterprises. The publication of the first volume of the "Astrographic Catalogue" was noticed in "KNOWLEDGE" last month. The photography for the Greenwich section of the "Chart and Catalogue" is complete, and the progress made in the observation of the reference stars for the astrographic plates has been so satisfactory that it is expected that the work will be completed next year. The revision of "Groombridge's Catalogue for 1810" and the determination of 4000 proper motions therefrom are complete, and the results are about to be published. Considerable progress has been made with the measurement of the photographs of Eros, taken in 1900 and 1901 for the solar parallax. The rainfall of the year 1903 was 35·54 inches, the heaviest ever recorded at Greenwich during the calendar year, but the amount of sunshine registered was a little above the average, and the number of observations made with the transit circle suffered no diminution through the unprecedentedly wet character of the year.

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The Smithsonian Expedition to observe the 1900 Solar Eclipse.

The Smithsonian Institution sent an expedition under Professor S. P. Langley to observe the total eclipse of May, 1900, at Wadesboro, S. Carolina, which was especially interesting in view of the fact that its leader had observed the famous eclipse of 1878, two complete solar cycles earlier, at Pike's Peak. Professor Langley observed with the same 5-inch telescope that he had used on the former occasion, and says that "the inner corona was filled with detail, but far less sharp and definite than he saw it on Pike's Peak in 1878. He could not identify any connection between the coronal structure and the presence of prominences, while his impression was that the details contained more ogival curves than straight streamers. Having in mind the wonderful structure seen with the instrument in the clear mountain air 22 years before, the impression was a disappointing one." This absence of connection between the prominences and the coronal structure was not borne out either by visual or photographic observations at other stations or by the photographs taken at his own camp, for in his general summary and conclusion Professor Langley says that "large prominences were present, and these appear to have been associated with regions of coronal disturbance." He goes on to say that "the equatorial streamers were followed on photographs to nearly four solar diameters, and were then lost by reason of diminished intensity rather than as appearing to end." This coronal extension, though not so great as that photographed by Mrs. Maunder in India in 1898, seems to be greater than any secured in any of the other expeditions in 1900. The feature, however, in the Smithsonian Expedition which excited the most interest was the use of the bolometer, and though its results were to a great extent negative in character, they were no less important. Professor Langley says: "In the bolometric observations the heating effect of the inner coronal radiations was recognised and found unexpectedly feeble. The results seem to indicate a comparative weakness of the infra-red portion of the coronal spectrum, alike inconsistent with the hypothesis that it radiates chiefly by virtue of a high temperature, or acts chiefly as a reflector of ordinary sunlight. This, taken in connection with the appearance of the corona, seems to support the hypothesis that the principal source of its radiations is of the nature of an electrical discharge. The well-known polarisation of its outer portions, and the presence of faint dark lines in the outer coronal spectrum, announced many years ago by Janssen and confirmed by the photographs of Perrine in the eclipse of 1901, prove that a small portion of the coronal radiation is due to reflected photospheric light. But the photographs of the

coronal spectrum by Campbell in 1898, and Perrine in 1901 indicate that the principal part of the coronal light is not reflected sunlight. Many are disposed to believe the main source to be the incandescence of particles due to the proximity of the hot photosphere, but so far as the writer is aware the spectroscopic evidence is equally in accord with the hypothesis of a glow electrical discharge. An example of such a discharge is found in the aurora of the terrestrial atmosphere, but while we can hardly deny the possibility of its existence in the case of the sun, the above observations do not seem to the writer to be conclusive on the point." It seems of the highest importance that bolometric observations should not be neglected in the eclipse of 1905.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Breeding of the White Stork at Kew.

THE pair of white storks (*Ciconia alba*) at the Royal Botanic Gardens, Kew, have again succeeded in hatching out nestlings, this being the third successive year. In 1902, five eggs were laid, but from those only three proved fertile, and only one nestling was ultimately reared. Last year torrents of rain put a speedy end to the domestic bliss of these interesting captives, the young being drowned in the nest. To avoid a similar catastrophe this year, a roof has been erected above the nest, which stands on a mound between the trunks of two large trees. In spite of every care, however, on the part of the keepers, and the assiduous attention of the parents, only one of the four birds hatched out now remains. This, it is to be hoped, will survive.

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Guinea-Fowl in a Roman Dust-heap.

A find of considerable interest and importance has just been made at Silchester in the course of the excavations being made there by archæologists. The find in question was the tarso-metatarsus of a guinea-fowl, which had recently been recovered from a Roman kitchen midden. That this bird was highly prized we may gather from the fact that around the leg, during the bird's lifetime, a bronze ring had been placed, and the remains of this, much corroded, encircled the bone when brought to the Natural History Museum for identification.

The value of this discovery lies in the fact that though the guinea-fowl is believed to have been originally introduced by the Romans, no similar remains of this bird have hitherto been found in this country. That our domesticated guinea-fowls of to-day are the descendants of those introduced by the Romans is hardly probable, though at what date they were re-introduced into our islands, or even into Europe, is unknown.

* * *

Hybrid Pheasants.

The remarkably fine series of hybrid pheasants in the collection of the Duke of Bedford was exhibited by Dr. Günther at the meeting of the Zoological Society on June 9. All had been killed, at various times, in the coverts at Woburn, and were the results of crosses between the many different species which have from time to time been liberated there. Some of these birds were of great beauty, but unfortunately they presented characters so subtly blended as to make it impossible to do more than hazard a guess at their parentage. That results of considerable scientific value would accrue from a series of properly conducted experiments made with a view to reproducing the crosses which these birds suggest, there can be no doubt. It is with a view to stimulate some such experiments that we now bring this matter before those of our readers who have the necessary space and material at their command.

Mr. J. L. Bonhote, who is now engaged in a series of extremely valuable experiments in the hybridization of ducks, in commenting on this exhibition, remarked that, judging from his experience, hybridization tended to reduce vigour, and that hybrids were either markedly *more*, or conspicuously *less*, ornamented than their parents. Further, he insisted that the less coloured birds were the more fertile, and the more coloured less fertile. As a word of warning in determining the origin of wild hybrids, he remarked that hybrids tend to produce the characters of species which were *not* the parents.

* * *

The Eggs of Darwin's Rhea.

The Hon. Walter Rothschild exhibited at the Ornithologists' Club on Wednesday, June 15, the first eggs of Darwin's Rhea laid in this country. They were laid in Tring Park, and were, he remarked, relatively larger than those of the Common Rhea, though the latter is much the larger bird. When freshly laid they were of a bright green colour, but rapidly faded to a parchment hue. In their green colour and more polished surface they further differ from the eggs of Rhea Americana.

* * *

Twite Breeding in North Devon.

Mr. Pearson exhibited at the meeting just referred to the nest and eggs of the Twite (*Linota montium*). This nest was found on the ground under a low bush on May 5. The parents were not taken, but were watched within 20 yards of the nest.

* * *

Yel ow-legged Herring Gull at Dover.

Mr. C. N. Rothschild, at this meeting of the Club, announced the fact that he had seen what he had no doubt was the yellow-legged Herring Gull (*Larus cachinnans*) flying in Dover Harbour on April 18. The conspicuous light yellow legs of this bird were plainly seen.

PHYSICAL.

An Apparatus for Preventing Sea-Sickness.

An ingenious apparatus has just been brought out in Hamburg, Germany, by Mr. O. Schlick, a naval engineer. This apparatus is designed both to augment largely the period of oscillation of the rolling movement of a ship and to diminish at the same time the amplitude of oscillation, both effects being based on the gryoscopic action of a fly wheel installed on board and performing a rapid rotation. The vertical axis of the apparatus is enabled to perform a pendulating movement in the central plane of the ship. The latter, on account of the rapid continuous oscillations of the wheel, is rendered insensitive to the effect of wave-motion, so as to eliminate practically any rolling movement. As the effect exerted by the device is rather energetic even with the smallest lateral oscillations of the ship, there will be no propagation of the motion. Thus the production of any strong balancing movement will be avoided, in contradistinction to the effects observed in the case of drift keels, which are not brought to bear before the rolling movements have assumed a high intensity. As regards the underlying principle of the apparatus, it should be remembered that a rotating body will oppose to any inclination of its axis a resistance the higher as the rotation is more rapid, and the weight of the body more considerable. As the forces producing the rolling movement of a ship need not be of an excessive intensity (in fact it is well known that 20 to 25 men running in proper time from one side of the deck of a large steamer to the other will produce rather considerable rolling movements of the ship), the weight of the apparatus need not either be very high. Mr. Schlick calculates that in the case of a ship 6000 tons in weight, a 10-ton fly wheel, 4 m. in diameter, will be quite sufficient. There will therefore be no difficulty in using the Schlick apparatus on ships of moderate dimensions, such as, for instance, cross-Channel steamers, where they will largely contribute to augmenting the comfort of the passengers.

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On Wireless Telephony by means of Hertzian Waves.

In a recent issue of *La Energia Eléctrica*, Madrid (May 25, 1904), Mr. G. J. de Guillén Garcia records some interesting experiments made by him, in conjunction with his son. In

connection with some wireless telegraphy researches, the son of the author happened to note that in the telephone of the Tommasi coherer, located at the receiving station, there was a "sound difference," which varied in accordance with the air-gap in the interrupter of the Rhumkorff apparatus. This suggested the idea that a similar apparatus would be capable of transmitting the human voice to a distance without the agency of the wire. The experiments had to be put off for some time because of the lack of a suitable outfit; but the author was eventually enabled, through the courtesy of Professor Marcel, of the Barcelona Seminary, to carry out his idea. The experimental arrangement is a rather simple one. At the transmitting station there is a Rhumkorff apparatus 3 cm. in spark length, as well as the necessary oscillator, a small antennæ, and an earthed conductor. Between the transformer (*i.e.*, the Rhumkorff coil) and a small battery of Grenet cells, there is a special microphone acting both as manipulator and as interrupter. The automatic interrupter of the induction coil is stopped, while the condenser is used for enforcing the oscillator spark. At the receiving station, there is a Tommasi coherer, connected to the receiving antennæ, and the earthed conductor. In a telephone receiver, the noise produced by the Hertzian waves on traversing the coherer is noted. On approaching the mouth of the microphone and singing or speaking, every sound vibration will be attended by an interruption in the passage of the electric current through the primary circuit of the transformer, the number of sparks in the oscillator thus being varied. The underlying principle shows, therefore, some analogy with the mechanism in an ordinary telephone. Any results so far obtained in the reproduction of singing are said to be quite satisfactory, whereas the rendering of language leaves much to be desired. The feeble point seems to be the difficulty of designing a microphone of sufficient intensity. Mr. Garcia, it is true, has remedied the imperfections of his apparatus to a certain extent by using a condenser and augmenting the potential difference. This, however, could not be driven too far, lest electric arcs be formed.

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On the Chemical Effect of Cathode Rays.

Dr. E. Bose, of Göttingen University, has for two years past made a close investigation of the simplest possible case of a chemical action of cathode rays, with a view to ascertaining whether or not the chemical conversion due to the rays is a purely electro-chemical phenomenon according to Faraday's law (see *Physikalische Zeitschrift*, No. 12, June 15, 1904). A solution of caustic potash, saturated in the hot state, was exposed for a long time to the effect of cathode rays in a convenient outfit allowing of a large electrolyte surface—in fact, about 200 sq. cm., being radiated upon intensely, when a reduction, attended by the formation of hydrogen, was noted. The amount of electricity absorbed by the electrolyte was measured with the aid of a hydrogen voltmeter under reduced pressure, this electricity being drawn off through a platinum electrode sealed into the bottom of the testing tube. As the hydrogen present in the vacuum where the discharges took place was partly dissociated into hydrogen and oxygen, a mixture of hydrogen and oxygen, containing hydrogen in excess, was withdrawn by means of the mercury air pump, and, after the gases due to this dissociation were eliminated by an explosion, the hydrogen in excess could be measured, and its pure condition confirmed. Now, in the case of the chemical effect of the cathode rays following Faraday's law—*i.e.*, being a purely electro-chemical phenomenon—the amount of hydrogen derived from the vacuum should be strictly the same as the one evolved in the voltmeter. A high degree of accuracy, it is true, was not to be anticipated, on account of the smallness of the effects and amounts of electricity in question, but the invariable result of the experiments was in opposition to the foregoing hypothesis, 1030 and even more times the amount obtained in the voltmeter being derived from the vacuum. There must, therefore, be, besides the electro-chemical action, another chemical effect of cathode rays, due obviously to the kinetic energy of the cathode ray particles, this hypothesis being borne out by the theoretical considerations of the author. It is shown that, in the most favourable case, an amount of hydrogen even 1600 times the electro-chemical amount would be obtained. But it should be remembered that, in most cases, the greater part of the kinetical energy of the rays is simply transformed into heat.

New Self-Recording Barometer.

The new self-recording barometer which Mr. W. H. Dines has designed, and which is made by Mr. J. Hicks, of Hatton Garden, grapples in an original and satisfactory way with the two problems of the recording barometer—the difficulty of registering very small differences, and of ensuring a high degree of accuracy. The curve traced by the recording pen is accurate to the one-two-hundredth part of an inch. The ends aimed at are attained by reducing the friction between all moving parts, and by the ingenious device of an automatic correction for temperature. The pen moves with a float in the lower cistern (the motion being multiplied by a lever); and this float is in the form of a hollow cylinder floating mouth downwards in the mercury. A rise of temperature lowers the level of the mercury in the lower cistern; but at the same time it makes the float swim higher in the mercury, because the air in the hollow cylinder expands with the same increase of temperature. The volume of air in the hollow float is so adjusted as to make the compensation perfect. Another useful device is the addition of what we may call a stationary pen, which is fixed to the frame, and which draws a line of reference on the reel of paper wound on the clock drum of the barometer. Any error in spacing the chart of the drum, or any carelessness in placing the chart on the drum, is thereby rectified, since this line can be taken as the zero line.

G.

ZOOLOGICAL.

The English Stoat.

The English stoat, according to Captain G. E. H. Barrett-Hamilton, differs from the stoat of Scandinavia—the true *Mustela erminea* of Linnæus—by having the tail coloured uniformly all round, instead of with the under surface much lighter than the rest. Moreover, it does not usually turn white in winter. Consequently, it is regarded as a distinct race—*Mustela* (or *Putorius*) *erminea stabilis*.

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Habits of African Fishes.

Some very interesting observations, based on specimens kept in the Aquarium, on the habits of many species of fish from the Nile are recorded in the Director's report of the Zoological Gardens at Giza, near Cairo, for last year. Many of these refer to the long-snouted fishes of the family *Mormyridæ*, all of which are peculiar to the African rivers, and some of which have a muzzle comparable to the trunk of an elephant. In a natural state all these fishes appear to be thoroughly nocturnal, but in captivity they soon learn to move about during the daytime, when they will search for the chopped worms on which they are fed. Specimens of the long-nosed species, known as *Mormyrus kannume*, generally spend the day lying quietly at the bottom of the tank, but after nightfall become very active, searching energetically after food. When a light is thrown on them their eyes shine in a very remarkable manner, sometimes appearing white and sometimes gleaming red. They have also a curious habit of swimming tail-first.

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Classification of Fishes.

Considerable modifications of the generally-accepted classification of fishes are suggested by Mr. C. T. Regan in the May number of the "Annals and Magazine of Natural History." The sturgeons and their extinct relatives are, for instance, regarded as the most primitive representatives of the bony fishes, and from this group is derived the bisher of the Nile and the other members of the now nearly extinct section of fringe-finned ganoids; while from the latter are descended the lung-fishes (such as the Queensland barramunda and the South American and African lung-fishes), which have generally been regarded as constituting a distinct order by themselves.

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Alligators and Crocodiles.

A remarkable display of ignorance and inaccuracy has been recently displayed by a correspondence in the *St. James's Gazette* with regard to the alleged occurrence of alligators in

Australia. The first writer stated that these saurians abounded on that island continent; this was derided by a second, who asserted that alligators were confined to America. A third correspondent correctly pointed out that an alligator is also found in China, but made the absurd mistake of asserting that the Australian representatives of the crocodilian order belong to the genus *Tomistoma*, represented solely by Schlegel's gharial of Borneo and Malacca. The strange thing about discussions of this nature is that people will rush into print without consulting some standard work on natural history (such as the "Royal Natural History"), or, still better, the invaluable series of British Museum "Catalogues," which, although they afford an absolute mine of authentic information, seem to be quite unknown to the amateur zoologist. It should, however, be mentioned that the term "alligator" has a double signation—a popular and a technical—either of which is perfectly legitimate. In the popular sense it is applied to all the broad-nosed crocodilians (in the same manner as rooks are generally called crows), in the zoological sense it is confined to two or three species of the former, respectively inhabiting North America and China, unless, indeed, the caimans of South America are included under the same title.

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Some Giant Fossil Reptiles.

One of the most gigantic of known fossil reptiles has been hitherto so generally known as *Brontosaurus* that it is somewhat a shock to find that this term, according to Mr. E. S. Biggs, of the Field Museum at Chicago, must give way to the earlier *Apatosaurus*. Of this monster, which attained a total length of something like sixty feet, two practically complete skeletons are known, one of which is preserved in the Field Museum, and the other in the Museum at Yale College. Of not less interest are the skeletons of giant toothless pterodactyles (*Pteranodon* and *Nyctosaurus*) which have been recently set up in American museums, some of these having a span of wing of fully fifteen or sixteen feet. The former type, which by some authorities is believed to have had a curious backward prolongation of the skull, is also peculiar in possessing a ring of bones in the eye, like birds. Pterodactyles probably seized and held their prey solely by their beak or jaws, but some of those dinosaurs, or giant land reptiles, which habitually assumed the upright posture seem to have used their fore-limbs for this purpose. For instance, the relatively small *Ornithomimus altus* appears to have raced after its prey, which was firmly gripped by the long and powerful claws of the front paws.

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A Horn Exhibition.

At the exhibition of sporting trophies recently held at Berlin, the number of specimens of deer antlers displayed was very great; many of them being remarkable for their large size or symmetry of form. Kaiser Wilhelm was one of the exhibitors. Medals were offered for the finest specimens.

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Sale of Great Auk's Egg.

A fine specimen of the egg of the great auk was sold the other day at Stevens's auction rooms for two hundred guineas, or two-thirds the price realised by an example sold a few years ago. In 1838 this egg was bought for £2, while in 1869 it was sold for £64. In 1898, after it had long been supposed to be broken, it was found among the effects of the daughter of the purchaser. In connection with this subject, it may be mentioned that a number of skulls and other bones of the great auk have been recently discovered in an old rubbish heap at Caithness; one of the skulls being now exhibited in the Geological Department of the Natural History Museum.

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Papers Read.

At the meeting of the Zoological Society held on May 17th, there was exhibited, on behalf of the Duke of Bedford, a sketch of a hind and fawn of Père David's deer (*Elaphurus davidianus*) from Hainan—a species previously believed to be now represented only by specimens living in European menageries. The fifth of Sir C. Eliot's series of articles on the naked-gilled molluscs of Zanzibar and East Africa was read; as was also a paper by Mr. Boulenger on a tree-frog from British Guiana which carries its eggs on its back. Mr. Beddard contributed notes on the anatomy of certain snakes belonging to the python family; and Dr. G. S. Brady furnished an account of water-fleas and other minute crustaceans collected in Natal.

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Flying Fish.

"Quill Pen" writes from Las Palmas: "In your number for April I notice a note on flying fish. I have, during the last year or two, frequently watched them as opportunity offered in the South Atlantic and Indian Oceans, and at times followed the flight of one through a glass, and am inclined to think the 'wings' may occasionally be used as organs of flight. When using them as such the fish appears to assume a more vertical position, resuming the horizontal position again when using them as a parachute. I have seen this vertical position assumed twice during a flight, in both of which progression appeared to be aided by distinct movement of the wings."

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The Nautilus and Flying Fish.

Mr. George Henslow writes: "In a note on p. 68 of the April number are some remarks upon these creatures. I watched both as carefully as possible through an opera glass on board ship, and the appearance of the Nautilus at a distance was that of a white, square sail above the water. As the vessel approached, the 'sail' turned out to be the shell seen endwise. How any motion of the expanded fins of the flying fish may be effected, it was not possible to observe; but the fish can do more than skim in a straight line. They can rise over an approaching wave, and dart to the side if necessary.

REVIEWS OF BOOKS.

The Analysis of Colour.—The value of Professor A. G. Green's "Systematic Survey of the Organic Colouring Matters" (Macmillan) resides in its completeness and its terseness. It is not a book to be read in an armchair by the pleasant light of the study lamp; but a manual of severe facts, formulæ, and symbols which present to the chemist, the manufacturer, the calico printer, the dye merchant, and the patent agent every accessible means of reference to the composition of the vast array of synthetic colouring matters that are sweeping away, by virtue of their cheapness, the vegetable dyes. If we say sweeping away, instead of "swept away," it is because, as Professor Green reminds us, the sharp line of demarcation between the artificial and the natural organic dye-stuffs can no longer be maintained; and the artificial production of indigo and the new synthetic products in other groups of colouring matters are tending still further to obliterate the distinction. If, indeed, one general conclusion emerges salient from the tables and records of the organic colouring matters, it is that there is no finality in the chemistry of colour. The volume before us consists of two parts, in the first of which Professor Green deals with the raw and intermediate products of artificial colour manufacture, extending them so as to include the most recent methods and material; and in the second of which he edits a dictionary of the colouring matters, based on the German tables of Drs. Schultz and Julius, which indicates as briefly as is compatible with clearness the commercial and scientific names, the empirical and constitutional formulæ, the methods of preparation and employment, the patents, and the literature of each colouring matter. The first volume on these lines was published ten years ago. Since that date 59 of the 454 colouring matters then described have become obsolete. On the other hand, 300 new colouring matters have been added. These figures do not exhaust, even in a numerical sense, the change and development in colour manufacture. Another 16 must be added to the 695 artificial colours to embrace those which are in a transitional state, between the employment of natural dyes and the supersession of such dyes by new syntheses. But beyond and above these facts is the far more important one that in the manufacture of colour, no patent, no discovery, confers lasting profit on its discoverer or owner. A discovery in industrial chemistry is like a message sent by wireless telegraphy; it can be tapped by any scientist in the neighbourhood who is provided with the appropriate apparatus.

Consequently advancement and wealth in the manufacture of what we may for convenience call the "coal tar" dyes are to be secured not by any isolated success or happy stroke of fortune, but by continuous application of economical methods, by unceasing chemical research, and by the co-operative efforts of a school of chemists. It is because the German manufacturers have realised these facts and English manufacturers have not, that the rewards of the discoveries of Perkins' mauve, Hoffman's violet, A. G. Green's primuline, have not been reaped by England, where they were first made, but in the long run by the German firms who have applied to colour making the levers of trained research and organised equipment. It is for this reason that 90 per cent. of the patents in Professor Green's tables are of other than English origin.

In Praise of Gardens.—The most complete justification that we can find for Mr. John Halsham's "Every Man His Own Gardener" (Hodder and Stoughton) is in a passage from his Introduction: "If there be one pursuit that can be commended as a general recreation, a hobby good for all temperaments, ranks, and employments, it is gardening. It is a stand-by that will come in with its solid results to fill any hiatus in the progress of our loftier concerns. If a party go into the cold shade of Opposition, or a company into liquidation; if a book, a picture, a play be damned, it is good to be able to shut one's gates on the mad world, and find one's marrowfats podding, one's nectarines reddening, faithful to their master's hand, heartening him to survive the earthquake even as they have done. There is no vote of censure, no critical cat-o'-nine tails which can touch that part of his work: and if he cares to try the popular suffrage again, he may find that people who have trodden on his pearls are not by any means incapable of relishing his peaches." That is not only a piece of extremely good writing, but it expresses in the fittest terms the reason for the love which most good Englishmen have for their garden; and it is a sufficient indication of the charm of a charming book. If Mr. Halsham's book were only charming, that would not, perhaps, be, in the eyes of many people, either a sufficient excuse for its title, or a sufficient reason why they should buy it. But it is full of the most practical information on soils and tilths, cropping, seed-sowing, manures, pricking, the hotbed, plagues and pests, potatoes and pruning, cuttings and bulbs. It is a compendium for the amateur gardener of town or country, and it is delightful reading for all who love "the massy-bronzed pears on the south wall, and the cauliflowers paling from cream to pure white under the green tent of their leaves"; or "who balance the gay fulfilment of the sweet-pea with the green promise of the marrowfat."

Miss Eleanor Ormerod.—In the autobiography of "Eleanor Ormerod, LL.D." (John Murray), which is edited by Professor Robert Wallace, of Edinburgh, appear a number of Miss Ormerod's letters to Dr. Fletcher. In one of them she humorously suggests that surely it should be recorded of her that "she introduced Paris-Green into England"; and in that phrase is summed up much of the charm, the modesty, and the persevering usefulness of Miss Ormerod, her life, and her work. She was born nine years before the accession of Queen Victoria; and one might say of her, without fulsomeness or exaggeration, that she was one of the great women of the Victorian Era. Beginning with no greater advantages than a love for living things, she attained a position in which she ranked as one of the first economic entomologists of the day. For half a century she was a close student; for half of that time her Annual Reports and pamphlets on injurious insects and common farm pests were beacons which lit the path of a revolution in agricultural entomology. The real work that she did is known to thousands of people, and is to be found in her correspondence with entomologists and agriculturists all over the world. The less concrete summary of it may be inferred from the impression which she made on her contemporaries and co-workers. She was Consulting Entomologist to the Royal Agricultural Society, Lecturer at the Royal Agricultural College; medals were conferred on her by scientific societies, not of her own country alone, but France and Russia. She was an LL.D. of Edinburgh, and many foreign societies at home, in the Colonies, and abroad were honoured by her fellowship. Space forbids that we should attempt even a brief summary of the main features of her scientific achievement. For that we must refer readers to this admirable biography and autobiography, which reveals Miss Ormerod as she appeared to all who were privileged to know her, even for the briefest period, or in the most accidental way, as the kindliest as well as one of the cleverest and most modest women of our time.

Physical Deterioration. Logical and clearly put, Mrs. A. Watt Smyth's views on "Physical Deterioration, Its Causes and Cure" (London: John Murray), might also prove of great instructional value if the right classes of people could only be made to read them. But in attributing the deterioration in physique of the poorer classes of English people to life in towns and in suggesting as remedies for it a greater regard for personal cleanliness, a purer supply of air, milk and other food, Mrs. Watt Smyth comes perilously near the pitfalls of over-generalisation. As an instance of the snare into which this tendency to generalisation may lead, we may quote one extreme instance, while admitting that it does not injure the general argument in favour of leading a healthy physical life if proper physique is to be attained. "The physical and intellectual beauty of the ancient Greeks," says the author, "of which proofs innumerable have been handed down in their literature and works of art, resulted . . . from their public games"! Nothing is less proved or less probable than that the intellectual success of the Greek nation resulted from anything of the kind. If it were true, then we might expect the highest intellectual product of our time to arise from the ranks of those who win Sheffield Handicaps or appear in the incomparable acrobatic feats of the modern music-hall. To the intellectual and political success of the Greeks, their geo-political position was probably the first contributory cause; and their wise hygienic rules of life were a consequence of success already attained. Similarly, if the factory laws of Great Britain were perfect; if the abolition of primogeniture made small holdings likely; if a greater imaginative sense drove poor English people to fresh air and pastures new in the Colonies; if, as a race, we were more thrifty and less self-indulgent—then the national physique might improve and public games become a well-ordered rite. But none of these initial causes, whose absence we have indicated, is by itself the universal panacea for good health; and we must decline to believe that even continued residence in towns is the sole cause of national physical deterioration. But having thus pointed out what we think to be the chief defect of this book, that it takes things too much for granted, and argues from generalities assumed to be truths, we have nothing but praise for some of the "cures" suggested. Purer milk is one of them, on which legislation ought to insist with much greater emphasis; and the prevention of children's work in hours when they should be at school is a thing on which we should insist with much greater emphasis than Mrs. A. Watt Smyth has courage to do. The abolition of the half-timer, and the insistence that the years of a boy's or girl's education should be devoted to education alone—intellectual and physical—these are among the greatest remedies for the intellectual as well as the physical stagnation of the masses of the people.

Geology. Mr. W. Jerome Harrison's "Text-Book of Geology" (Blackie and Son) has reached a fifth edition. A valuable addition is a table showing the Range in Time of Invertebrate Fossils. This useful book has been otherwise revised and brought up to date in accordance with the most recent additions to our knowledge of rock formation.

Chronology. In "Astronomical and Historical Chronology" (Longmans, Green and Co.), Mr. William Leighton Jordan has set himself the task of showing reason for such a reformation of historical chronology as would bring it into accordance with the method of numbering the years B.C. which has been adopted by astronomers. In other words, he seeks to prove that the astronomical method of placing a zero year between the B.C. and A.D. years is intrinsically superior to the historical system which places 1 B.C. and 1 A.D. in juxtaposition.

Geometry. "Constructive Geometry" (Blackie and Son), by John G. Kerr, LL.D., is arranged for a first-year's course in science. Its subject matter is virtually the same as that of the first three books of Euclid, but from the construction and examination of drawings the pupil is taught to form ideas about the properties of lines, points, circles, &c., which it is hoped will assist his subsequent comprehension of Euclid's method of dealing with abstract principles.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Collecting Land and Fresh-Water Mollusca.

Some useful hints on collecting land and fresh-water mollusca were given some time ago in the "American Journal of Applied Microscopy" (September, 1902), which has now unfortunately ceased publication; and I think an abstract of some of these hints may prove of service to those who have not seen the larger article. For land shells a "Ferriss" hoe is very useful. This is made by getting a small light-handled garden hoe, and having the blade cut down at a machine shop. It should be about three inches wide on top, and taper to a sharp point; the handle being cut off so that it is as long as a walking-stick. This makes a most convenient tool for turning over logs, breaking up rotten wood, and digging around stumps and among dead leaves. A pair of fine curved-pointed forceps is necessary for picking up small species. Small glass bottles should be carried, as the smaller species are apt to get lost in the dirt and slime if put in the same receptacle as the larger ones. It is better not to put the small species in alcohol as they are collected, as they are then killed at once with the animal more or less extended. If put in a dry bottle and left a few hours they will withdraw into their shells, leaving the aperture clear and fit for examination. This is especially necessary with the *Pupidae*, where the arrangement of the teeth around the aperture is a specific characteristic. For the larger species tin cases of a convenient size for the pocket are most convenient, and specimens from different localities should be kept separate as far as possible. For the fluviatile species a dipper is necessary. This can be made from an ordinary tin one, by removing the bottom and substituting one of fine wire cloth. By removing the end of the handle the dipper can be slipped on to the end of a stick when in use. This is especially useful for sifting the mud and sand from the bottom, where so many small species live, which would otherwise not be found. It will probably be more convenient and thorough to empty the contents of the dipper into a pail, and to carry the whole home before attempting to pick out the shells. The whole mass can then be spread out into the sun to dry and become friable, after which the shells can be easily separated and picked out, an ordinary reading glass being used if necessary.

The land species love dampness and darkness, and are, therefore, to be looked for under logs, bark, and leaves in suitable localities. Many species bury themselves in rotten logs, which must be broken up with the hoe. Accumulations of dead leaves around fallen trees, thick grass and thickets along the margins of ditches and streams will usually repay examination, and should be carefully gone over with fingers and hoe. Coniferous forests are usually quite barren of molluscan life. Nearly every permanent body of water has its molluscs, varying according to its character. Some species are found only in rapid-flowing water, others only in still water and ponds. The low places in woods, which dry up in summer, have a number of species not found elsewhere, and which bury themselves in the mud when it dries. Sand banks in rivers and lakes have many of the smaller species.

The larger *Helices* should not be put into alcohol, as this makes subsequent removal of the animal almost impossible. They should be boiled as soon as possible, nearly hot water being useless. A small wire strainer with a long handle is convenient for holding the snails during this process, and saves difficulty in fishing them out, with consequent risk of over-boiling. The time varies according to the size and species, say from 10 to 60 seconds. If not boiled enough the muscular attachment is not loosened, whilst, if boiled too long, the animal is apt to break in two, and thus give trouble in extracting. Only a few should be boiled at a time, as they "pull" easier while warm. When boiled, the animal must be slowly and carefully pulled out, too much haste causing it to break, leaving the apical whorls in the shell. The curved points of the collecting forceps serve the purpose, and hooks of different sizes can be made from safety pins tied to small wooden handles. A small fine-pointed dental syringe is very useful in starting the animal, or in case it breaks, in which case soaking in alcohol for twenty-four hours usually causes sufficient contraction of the remnant to enable it to be washed out by the syringe. After extracting, the interior of the shell must be well syringed. Any mucous must be removed by small sponges attached to fine copper wire, or when dry it will disfigure the specimen. The outside must be scrubbed with a soft nail or tooth brush, no oil or acid being used on any of the land shells. In the small species the animal can be left. After keeping in a dry place for a short time the animal will retire far into its shell, which must then be put into 25 per cent. alcohol for a day or two, and then dried in the air, after which no offensive odour will be left. Either before or after drying the shells can be cleared by shaking in a bottle with fine clean sand.

In the operculate species, it is desirable to retain the opercula, or part of it. These are easily removed from the animal and, after being cleaned, should be put inside the shell, and the aperture plugged with cotton wool. All foreign matter, both inside and outside the shell, must be carefully removed by thorough washing; deposits of lime or oxide of iron on the water species can be removed with oxalic acid, either by immersion or brushing with a soft brush, but the operation must not be too prolonged or the shell will be injured.

The larger bivalves can be well washed, and, if necessary, scraped off with the knife, as soon as found, care being taken not to injure the epidermis. They can be boiled, when the shells will open and the animals be easily removed, or the muscles which hold the valves together can be cut with a thin-bladed knife and the animal scraped out, care being taken not to break the edge of any fragile species. All traces of animal matter must be removed; and, after thorough washing, the valves can be tied together with string until thoroughly dried, but coloured twine must not be used as it is apt to stain the shells. Any incrustations can be removed with oxalic or muriatic acid, but the specimens must be frequently washed and care used. The smaller bivalves are best put into dilute alcohol for a day or two and then dried. If left too long the shells are apt to open, which looks unsightly.

Both in collecting and cleaning, the specimens from each locality should be kept carefully separated and labelled, as the study of the geographical distribution of the mollusca is most important, and to be of value must be based on accurate work.

Ground Glass for Diagrams for Lantern Slides.

There are several photographic methods of making lantern slides of drawings and diagrams, of which the wet-plate process is perhaps the best; but recently it occurred to me to try a simple method, which has given most satisfactory results, though I do not remember to have seen it suggested elsewhere. All that is necessary is to draw or write with a hard pencil—a 6 H for choice—on ground glass squares $3\frac{1}{4} \times 3\frac{1}{4}$, of as finely ground glass as possible, then to flood the ground side of the glass with dilute Canada balsam in xylol or benzol. Cover with an ordinary lantern-slide covering glass, and bind in the usual way. The only precaution necessary is to avoid imprisoned air-bubbles, and this is not difficult when a dilute solution is used. The glasses must, of course, be first carefully cleaned. The result will be that the ground glass is made transparent, whilst the pencil lines become more distinct.

Royal Microscopical Society.

May 18, 1904. The President, Dr. Dukinfield H. Scott, F.R.S., in the chair. The Secretary called attention to two microscopes that had been presented to the Society. One was made by Ladd about 1864. It had chain movements to the coarse adjustment and to the stage, the motion being particularly smooth and free from back-lash. The fine adjustment was effected by a lever hanging from the milled head of the coarse adjustment, by means of which a very slow motion could be given. The other instrument was a small portable microscope, bearing no date, but similar to one made by Cary. Mr. F. W. Watson Baker exhibited a new objective changer, made by Watson and Sons, also a device designed by Mr. W.

Rosenhain for mounting specimens of irregular shape, such as sections of metals, so that the polished surface to be examined was normal to the optic axis of the microscope, thus obviating the necessity for a levelling stage. A third exhibit consisted of troughs, invented by Mr. T. G. Kingsford, suitable for fluids for light filters, or for examining aquatic life. They were constructed in various sizes of two flat discs of glass, such as were used for modern clocks, clipped round the edges by a thin metal band, leaving a suitable opening at the top. The band is drawn tight by means of screws near the ends, leakage being prevented by a lining of rubber strips. These tanks can be readily taken to pieces for cleaning, and will withstand sudden changes of temperature. A note by Mr. A. A. C. Eliot Merlin on Mr. Nelson's new formula amplifier was read. The amplifier consists of a negative lens placed in the rear of the objective, and was calculated by Mr. Nelson for the author, to enable him to make some delicate microscopical measurements. With the usual arrangement of a low-power eyepiece and screw micrometer, the magnification afforded by high-power objectives was insufficient to ensure accuracy in all cases, and it was not desirable to use more powerful eyepieces as the spider lines then appeared too coarse. The author found the amplifier yielded especially good results when used for micrometrical purposes, and he suggested its application to students' microscopes for quickly obtaining an increase of magnifying power. Mr. Nelson's formula for the amplifier was given. A note on Grayson's 120,000 Band Plate, by Mr. Nelson, was then read. The band was resolved strongly by an apochromatic oil immersion $\frac{1}{8}$-inch, 1·43 N.A., and a 5 eyepiece. It was also resolved by a semi-apochromatic $\frac{1}{10}$-inch, 1·3 N.A., and 5 eyepiece, and by an old achromatic water immersion $\frac{1}{16}$-inch, 1·2 N.A., but in the last case the lines appeared to have irregularities. The 90,000 band was resolved by an apochromatic $\frac{1}{4}$-inch, ·96 N.A., with some difficulty. The author remarked that the latest books on physical optics state that $\frac{1}{80000}$-inch is the theoretical limit for microscopical vision. Mr. Nelson stated that ruled lines are more difficult to resolve than diatoms of equal fineness. He said the best screen is made from a saturated solution of acetate of copper, many times filtered, to which a very small quantity of methylen blue should be added. Sunlight with a Heliostat was used, and the light made oblique in one azimuth. The theoretical resolving limit for oblique light may *roughly* be taken at 100,000 times the N.A. of the objective. Dr. Hebb remarked that when this plate was exhibited at the Royal Society's Conversazione some of the lines, though resolved, appeared weaker than others. Mr. E. E. Hill said this was due to the objective used having an aperture of only 1·1 N.A. Mr. Conrad Beck exhibited some flower seeds.

Quekett Microscopical Club.

The 414th ordinary meeting of the Club was held on May 20, at 20, Hanover Square, W., the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. Mr. H. Wallis Kew, F.Z.S., gave an interesting account of the False-Scorpions or Chelifers, illustrating his description with a number of lantern slides. The Chelifers, or lobster mites, as they are popularly called, form a distinctive though little studied Order of the Arachnida. They have been known to science ever since the time of Aristotle, who classed them with the true Scorpions, a mistake which was perpetuated for over 2000 years. Of retiring habits and minute size they may be found in all quarters of the world in suitable places. Shunning the light they conceal themselves under bark, or among mosses and dead leaves, where they lie motionless until their prey wanders within the reach of the terrible pedi-palps or forcep-like claws of the second pair of appendages, which instantly close on the victim, and transfer it to the chelicerae, the smaller forceps near the mouth, by which the victim is held while the juices are sucked out.

Mr. Kew referred at some length to the habit, peculiar to this Order, of attaching themselves by the forceps to the legs of other insects, by which they are transported from one place to another. Sometimes more than one Chelifer is found on the same insect, and there are recorded instances of as many as six, eight, and ten being found so attached. The habit has been known for over a century and has been recorded from every quarter of the world, but its object is still one of the puzzles of science. They do not appear to be parasites, and the fly appears too large to be a victim, so it has been suggested that they are merely stealing a cheap ride at the fly's expense.

Mr. D. J. Scourfield then gave a description of Apstein's Quantitative Plankton Net, which had been devised for the determination of the exact quantity of organic life in a given volume of water. The net had been used successfully on the Scotch lochs, and a specimen net, with photographs showing the method of use, was exhibited to the members.

Daphnia and Vorticella.

Mr. Caffyn, of Hornsey, writes: "I have recently collected a quantity of the Great Water Flea at Dorking, and practically every one of them is covered with Bell Animalcules. I think these are chiefly *Epistylis*, but there are a few *Vorticellæ*. In *Ponds and Rock Pools*, Mr. Henry Scherren says, on page 157, that it has been stated that the common water-flea never bears about with it any of the Bell Animalcules that flourish so luxuriantly on the *Cyclops P.*; this is stated to be due to a slimy film. Mr. Scherren goes on to state that he does not know as to the film being there or not, but he thinks plenty of the *Daphnia* could be found bearing these Vorticellidans, and he says that he has been told by pond-hunters that they have seen them in this state. I do not know if the matter has been definitely proved before; if not, I can certainly verify it now."

Notes and Queries.

W. N. Bone, Hove.

I am glad that Mr. Warburton's articles on Mites have decided you to take up the definite study of the *Acari*. There is so much work to be done here that is well within the powers of anyone who is interested in the subject. Unfortunately, the literature of the *Acari* is in a very unsatisfactory and incomplete state, and I am afraid I can give you no useful references other than those mentioned in the articles referred to. You will find the pages devoted to the subject in "Carpenter" useful as a beginning, however. The articles on Spiders and Mites in the forthcoming volume of the Cambridge Natural History are contributed by Mr. Warburton, and are now in the Press. With regard to killing the very smallest specimens, Mr. Warburton tells me that there is nothing better than boiling water, and that you must try to straighten the legs with a camel-hair brush, under a lens. He says chloroform increases this difficulty.

J. C. Miller, Willesden.

As far as I can gather from your description and drawing, the infusorian referred to must surely be the common *Paramæcium*, or "slipper animalcule." Its length is generally about 200 to 260 μ (μ = ·001 millimetre, and is the standard of microscopical measurement). It is of a very much lower order of life than *Hydra*, and is really unicellular, though the radial striations of the pronounced cortex give it a multicellular like appearance. There is therefore no definitely marked-off body cavity or *enteron*, though it has a "buccal groove" which leads into a fairly definite mouth, but this communicates direct with the semi-fluid protoplasm within. There is a large nucleus, and a smaller micronucleus, and two contractile vacuoles, which you may have mistaken for eyes. When feeding, the animalcule swallows with a sort of gulp, which carries the particle of food inward - enveloped by a globule of water, which is gradually absorbed later, and any remaining particles subsequently ejected at a soft place in the cortex, which may be looked upon as a potential though not a true or actual anus. It is probably this enveloping globule of water and the curiously sudden method of swallowing that you have mistaken for a "bag." I am sorry to have left your question so long unanswered, but it has been due to circumstances beyond my control, as explained last month.

Micro-Fungi for Distribution.

By the kindness of Mr. C. H. Caffyn, of Hornsey, I am able to offer a limited quantity of specimens of micro-fungi, mostly named, suitable for mounting as opaque objects. Those wishing to avail themselves of this offer should apply without delay, utilising and complying with the terms of the coupon to be found in the advertisement pages of the current issue of this magazine.

Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.

The Face of the Sky for July.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 3.49, and sets at 8.19; on the 31st he rises at 4.23, and sets at 7.49. The earth is at its greatest distance from the Sun on the 5th, when the diameter of the Sun is a minimum, being 31′ 30″·66.

Sunspots and prominences may usually be observed on clear days, though the change of solar activity to maximum is proceeding somewhat slower than in recent cycles.

The position of the Sun's axis and equator may be derived from the following table:—

Date.	Axis inclined from N point.	Centre of disc, N of Sun's equator
July 1 ..	2° 36′ W	3° 4′
,, 11 ..	1° 56′ E.	4° 7′
,, 21 ..	6° 23′ E.	5° 3′
,, 31 ..	10° 35′ E.	5° 50′

THE MOON:—

Date.	Phases	H. M.
July 5 ..	☾ Last Quarter	10 54 p.m.
,, 13 ..	● New Moon	5 27 a.m
,, 19 ..	☽ First Quarter	8 46 p.m.
,, 27 ..	○ Full Moon	9 42 a.m
July 3 ..	Apogee	5 24 a.m
,, 15 ..	Perigee	4 12 a.m.
,, 30 ..	Apogee	8 6 p.m.

THE PLANETS.—Mercury is in superior conjunction with the Sun on the 9th, and therefore during the earlier part of the month he is out of range. Towards the end of the month he is an evening star, and sets about 8.45 p.m.

Venus is unobservable, being in superior conjunction with the Sun on the 8th.

Mars rises only about an hour in advance of the Sun, and therefore for all practical purposes is unobservable.

Jupiter rises about 11.20 p.m., near the middle of the month. He is in quadrature with the Sun on the 22nd, and in conjunction with the Moon at 1 a.m. on the 7th. The polar semi-diameter of the planet is 18″·5 on the 16th.

Saturn is coming into a more suitable position for observation in the evenings; he rises about 10.15 p.m. on the 1st, and about 8.15 p.m. on the 31st. Near the middle of the month the planet is on the meridian about 2 a.m.

The apparent diameters of the outer major and minor axis on the 8th are 42″·7 and 16″·3 respectively, whilst the polar diameter of the ball is 17″·0.

The planet will be near the Moon on the evening of the 28th.

Uranus is becoming more favourably situated for observation at convenient times, being on the meridian about 10 p.m. on the 15th. His position on the confines of Sagittarius and Ophiuchus may be seen on reference to the chart in the last issue.

Neptune is out of range for observation.

Meteors.—The most conspicuous shower is the δ Aquarids, which occurs on the 28th; they are slow moving and long. The radiant is situated in R.A. 339°. Dec. S. 11°.

Comet a 1904 is but a poor object, faint and beyond the range of small telescopes.

THE STARS:—

About 9 p.m. near middle of the month:—

ZENITH . Draco, Hercules, Lyra.

SOUTH . Corona, Serpens, Ophiuchus, Libra, Scorpio.

EAST . Delphinus, Aquila, Capricornus; Saggittarius to the S.E.; Pegasus and Cygnus to the N.E.

WEST . Boötes, Great Bear, *Cor Caroli*, Leo, Virgo.

NORTH . Ursa Minor, Cassiopeia. *Capella* on horizon.

TELESCOPIC OBJECTS:—

Double Stars:—5 Serpentis, XV.^{h} 13^m, N. 2° 13′, mags. 5·1, 10; separation 10″.

β Serpentis, XV.^{h} 41^m, N. 15° 44′, mags. 3·5, 10; separation 31″.

ξ Cephei XXII.^{h} 1^m, N. 64° 8′, mags. 4·7, 7; separation 6″.

δ Cephei XXII.^{h} 26^m, N. 57° 55′, mags. 4·2, 7; separation 40″. A pretty pair for small telescopes, yellow and blue. It is also a variable star; period 5^d 9^h, with a quick rise to maximum in 1^d 9^h.

Clusters.—M5 (Libra). A compact cluster situated about one third of a degree north of the double star 5 Serpentis; when seen through a pair of opera glasses it appears like a large nebulous star.

N.G.C. 6633. Cluster in Serpens. About one-third of the way between θ Serpentis and α Ophiuchi (visible to naked eye).

THE Government Plant Bureau of the United States has just issued suggestive information to the American farmer as to the value of many weeds. Hundreds of tons of dried weeds are annually sent from Europe (not much from England) to the United States, mostly for their drug value. For instance, last year saw ten tons of dried dandelion roots cross the Atlantic. These were worth a trifle over twopence a pound, or a total of some £230, all of which might be considered as wage earned in Europe. In the same period, 250 tons of burdock, used for blood diseases, and worth as much per pound as dandelion, accompanied them. Ten tons of poison hemlock, fifteen tons of tansy, sixty tons of hoarhound, are a few other annual importations of weeds which have earned the malevolent hatred of the American farmer. Thorough as ever, the Plant Bureau gives full directions as to when to gather the various roots, leaves, or flowers; how to dry them, &c. "Whatever may be said of paternal government," remarks the *Agricultural Economist*, "the practical interest which America takes in the welfare of her greatest industry is proving of very real value to her agriculturists."

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

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Contents and Notices.—See Page VII.

Practical Meteorology.

I.—Temperature of the Air.

By WILLIAM MARRIOTT, F.R.Met.Soc.

IT is curious what vague ideas many people have respecting the weather, and of the instruments employed for recording its changes. The word "glass" is often used indiscriminately for the Barometer and for the Thermometer; and the word "Barometer" is also occasionally used to indicate the Thermometer, and *vice versa*. It is not supposed that any of the readers of "KNOWLEDGE" have fallen into these errors, but perhaps some information on meteorological instruments and the results derived from their observation may be of service.

We are all affected in some way or other by weather changes, and our feelings tell us when it is cold or warm; but for systematic observation of these changes it is necessary to have a definite standard for comparison, and for this purpose we use the Thermometer.

It goes without saying that everyone knows that a thermometer consists of a fine glass tube with a bulb blown on at one end, and that it is partly filled with some liquid, usually mercury or alcohol, which expands on being heated, and contracts on being cooled. The tube is marked off in degrees so that the changes of the liquid can be measured on a definite scale. The Fahrenheit scale is the one used in this country, in which the freezing point is 32°, and the boiling point 212°. On the Continent the Centigrade scale is generally employed, in which the freezing point is 0°, and the boiling point 100°.

For meteorological purposes the thermometers should be sensitive instruments and of the best construction, and they should be verified at the Kew Observatory in order that their errors may be determined and the necessary corrections supplied. In order to obtain the highest and lowest temperatures self-registering thermometers must be used. The maximum thermometer may be either on Negretti and Zambra's or on Phillips's principle. In the former the tube is bent near the bulb, and the bore greatly contracted; the mercury, in expanding, is forced through this contraction but is not permitted to recede into the bulb on a lowering of temperature. It therefore remains at the highest temperature. In Phillips's thermometer a small air bubble divides the mercurial column, the detached portion remaining at the extreme position to which it has advanced, thus registering the highest temperature.

In the minimum thermometer spirit is employed, and in it there is immersed an index. When the temperature falls the spirit draws the index along with it, but on rising again the spirit passes the index, leaving it at the lowest point to which it had been drawn.

In order that these instruments may indicate as nearly as possible the true temperature of the air, and that the results at various places may be comparable with each other, they are placed in a Stevenson screen, with their bulbs 4 feet above the ground (Fig. 1.) This screen, which is a louvre boarded box painted white, is placed in the open over grass, and away from walls, &c.

In this country it is the recognized custom to read the thermometers at 9 a.m. and to enter the reading of the

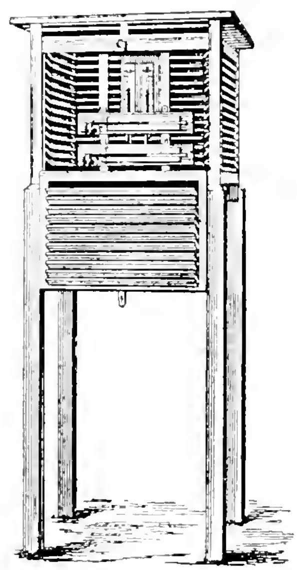


Fig. 1.—Stevenson Thermometer Screen.

maximum thermometer to the previous day. For all practical purposes the mean temperature for the day may be obtained by adding the maximum and minimum readings together and dividing the result by 2, thus: Max. 65·0°, min. 43·0° = mean 54·0°. From these two thermometers we are thus able to obtain for each day the highest, the lowest, the mean, and the range of temperature. They do not, however, indicate at what times the extremes took place, so it is the custom at first-class observatories to employ photographic self-recording instruments for this purpose. Previous to the introduction of photography it was the practice at the Royal Observatory, Greenwich, from 1840 to 1847, for the observers to read the thermometers every two hours, day and night which was a very laborious proceeding. At the observatory on Ben Nevis *hourly* observations are regularly made, as it is impracticable to employ self-recording instruments in that extremely damp and cold climate.

The photographic self-recording instruments are very costly, and need special buildings for their equipment, and so can only be employed at first-class observatories. By the introduction, during recent years, of the Richard pattern of self-recording instruments, it is now possible for observers to provide themselves at a moderate cost with a small but useful thermograph, which can be placed in the Stevenson screen, and which will give a continuous record of the changes of temperature for a whole week.

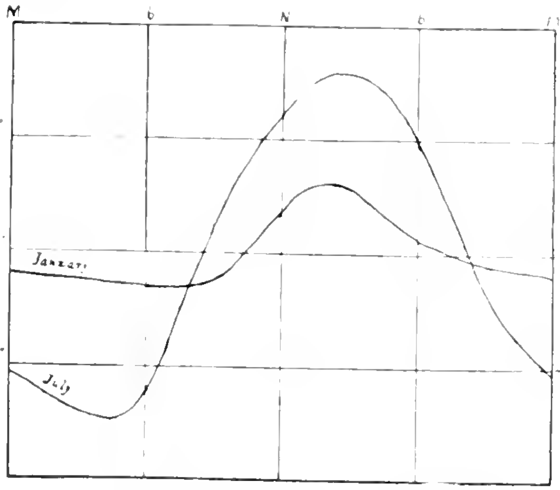


Fig. 2.—Summer and Winter Diurnal Range of Temperature.

The following values show the annual diurnal range of temperature at Greenwich, based on the 20 years' observations 1849-1868, those with the + sign indicating that the values were above, and those with the − below the mean for the day:—

Mid	− 3·4	6 a.m	− 3·8	Noon	+ 5·1	6 p.m.	+ 2·0
1 a.m	− 3·7	7 ,,	− 2·6	1 p.m.	+ 5·7	7 ,,	+ 0·5
2 ,,	− 4·0	8 ,,	− 1·1	2 ,,	+ 5·9	8 ,,	− 0·8
3 ,,	− 4·3	9 ,,	+ 0·7	3 ,,	+ 5·5	9 ,,	− 1·8
4 ,,	− 4·5	10 ,,	+ 2·5	4 ,,	+ 4·6	10 ,,	− 2·4
5 ,,	− 4·4	11 ,,	+ 3·9	5 ,,	+ 3·4	11 ,,	− 3·0

It will thus be seen that the temperature is at its minimum just before sunrise, and attains its maximum between 1 and 2 o'clock in the afternoon. Fig. 2 gives the summer and winter diurnal range of temperature.

We might possibly imagine that the temperature would progress uniformly day by day from its lowest point in winter to its greatest height in summer. But such is by no means the case. The variability of temperature is very great.

A striking instance occurred in January, 1901. At Swarraton, near Alresford, Hants, the minimum on the 9th was as low as − 1·9°, but the maximum on the 10th was as high as 49·2°, thus showing a range of 51·1° in two days. In consequence of this great variability, it will be understood that observations must extend over a large number of years before the daily irregularities can be smoothed out. Even 50 years is not long enough to produce a smooth curve, as will be seen from Fig. 3, which gives the mean temperature on every day at Greenwich for the 50 years 1841-1890. This Fig. is reproduced from a paper by Mr. W. Ellis, F.R.S., in the *Quarterly Journal of the Royal Meteorological Society*, vol. xviii., p. 238.

Some of the interruptions in the annual march of temperature are very marked. These are not confined to the south of England, but extend over a much wider area. Dr. Buchan some time ago investigated the temperature of Scotland for a number of years, and showed that the following interruptions occur:—

Six cold periods.	1 Feb.	7-15
	2 April	11-14
	3 May	9-14
	4 June 29-July	4
	5 Aug.	6-11
	6 Nov.	6-12
Three warm periods.	1 July	12-15
	2 Aug	12-15
	3 Dec	3-9

These interruptions are, no doubt, associated with certain types of weather which are accompanied by winds from definite directions. Generally speaking, the effect of the wind is as follows:—

N. winds depress the temperature throughout the year.

N.E. winds do the same, except in summer, when their effect is small.

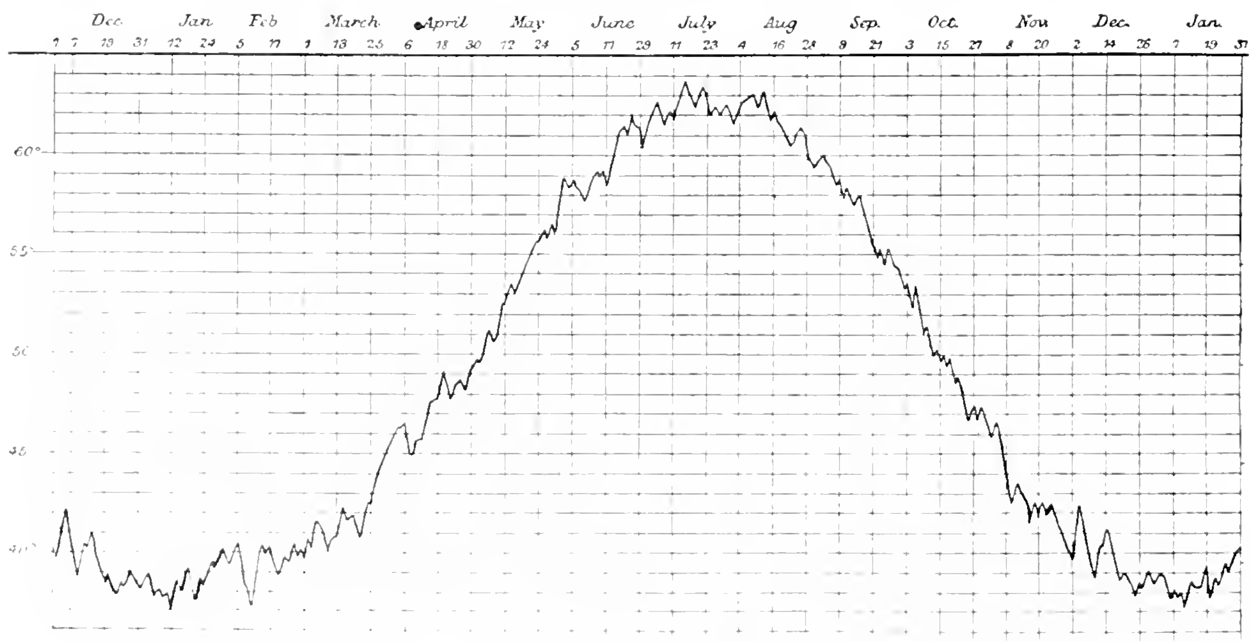


Fig. 3.—Temperature on each day of the year, 1841-1890.

E. winds lower the temperature very much in winter, and generally raise it in summer.

S.E. winds do nearly the same, but less markedly in winter.

S. winds raise the temperature much in winter, but scarcely affect it in summer.

S.W. winds do nearly the same.

W. winds decidedly raise the temperature in winter, and lower it in summer.

N.W. winds lower the temperature generally, but mostly in summer.

The most satisfactory way to ascertain the distribution of temperature over a country is to prepare an isothermal chart. This can be done by plotting on a map the temperatures at a considerable number of stations, and joining up the readings of the same values by lines which are called "isothermals." From an examination of such

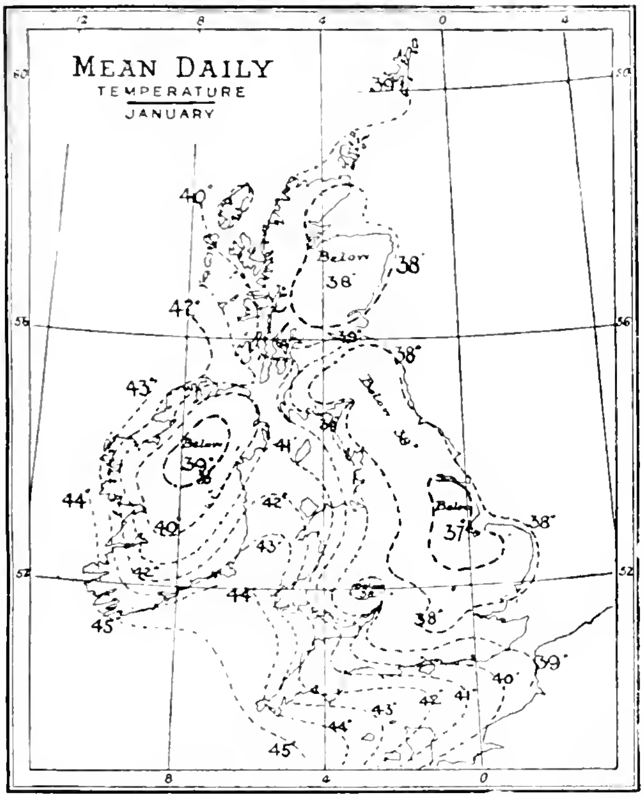


Fig. 4.—Isothermals over the British Isles. Winter.

maps, it is seen that the range of temperature is greater over inland districts than near the coast. The sea has a great equalizing effect on the temperature of the air round the coasts, while inland the ground is warmed up to a greater extent by the sun during the day, and is chilled by radiation at night, and so has a more marked effect upon the air temperature.

Isothermal charts of mean temperature for the British Isles for the winter month of January and for the summer month of July are given in Figs. 4 and 5. These are based on 25 years' observations, 1871—1895, and are from a paper by Messrs. R. H. Scott, and F. Gaster, in the *Quarterly Journal of the Royal Meteorological Society*, vol. xxiii., p. 275.

The influence of the warm water of the Atlantic is very clearly manifest in the January chart in the higher temperatures on the western and south-western coasts than over the central and eastern districts. In the summer the sea has a moderating effect on the air round the coasts; the temperature thus not rising to the extremes which are experienced at inland stations.

The temperature declines with increase of altitude at the rate of nearly 1° in 300 feet; so, in preparing isothermal charts, the temperatures must be corrected proportionately for the height of the station above sea-level. The observations on Ben Nevis give a reduction of 1° in 270 feet. Experimental observations in the free air are now being made with self-recording instruments raised by kites, in order to secure more complete data for determining the rate of decrease of temperature with altitude.

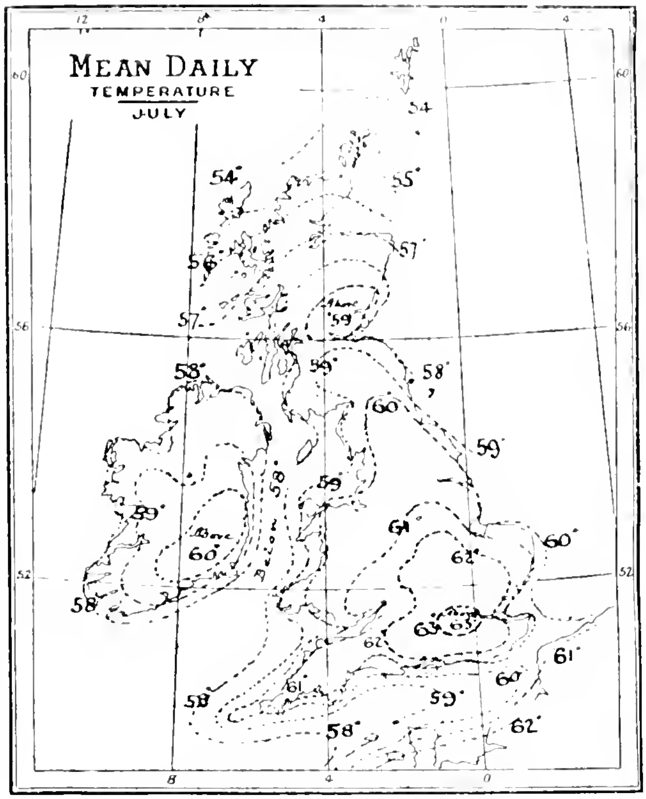


Fig. 5.—Isothermals over the British Isles. Summer.

In the valuable series of meteorological observations which is issued each year from Stonyhurst Observatory a table is published from which it appears that last year's weather, unpleasant and surprising as it was, broke few old records at meteorological stations outside London. It was a year which, as Father Sidgreaves observes, will probaby be known for some time to come as the "wet year," but it was not the wettest known. For example, though its rainfall (at Stonyhurst) was 58.9 in., and 11 in. above the average, it was more than 3 in. below the 62.1 in. of the year 1866; and though rain fell on 231 days, this was not so bad as the 319 days out of 365 on which rain fell in 1872. A fact which emerges from Father Sidgreave's notes, though it is not connected with last year's weather, is that between the highest recorded reading of the barometer in the last fifty-six years, which was 30.597 on January 9, 1896, and the lowest, on December 8, 1886, of 27.350 in., there is a difference of 3.247 in. That we may take to be equal to a difference in pressure on the human frame of not less than a pound and a half to the square inch—not less than a weight of half a ton on the whole human body.

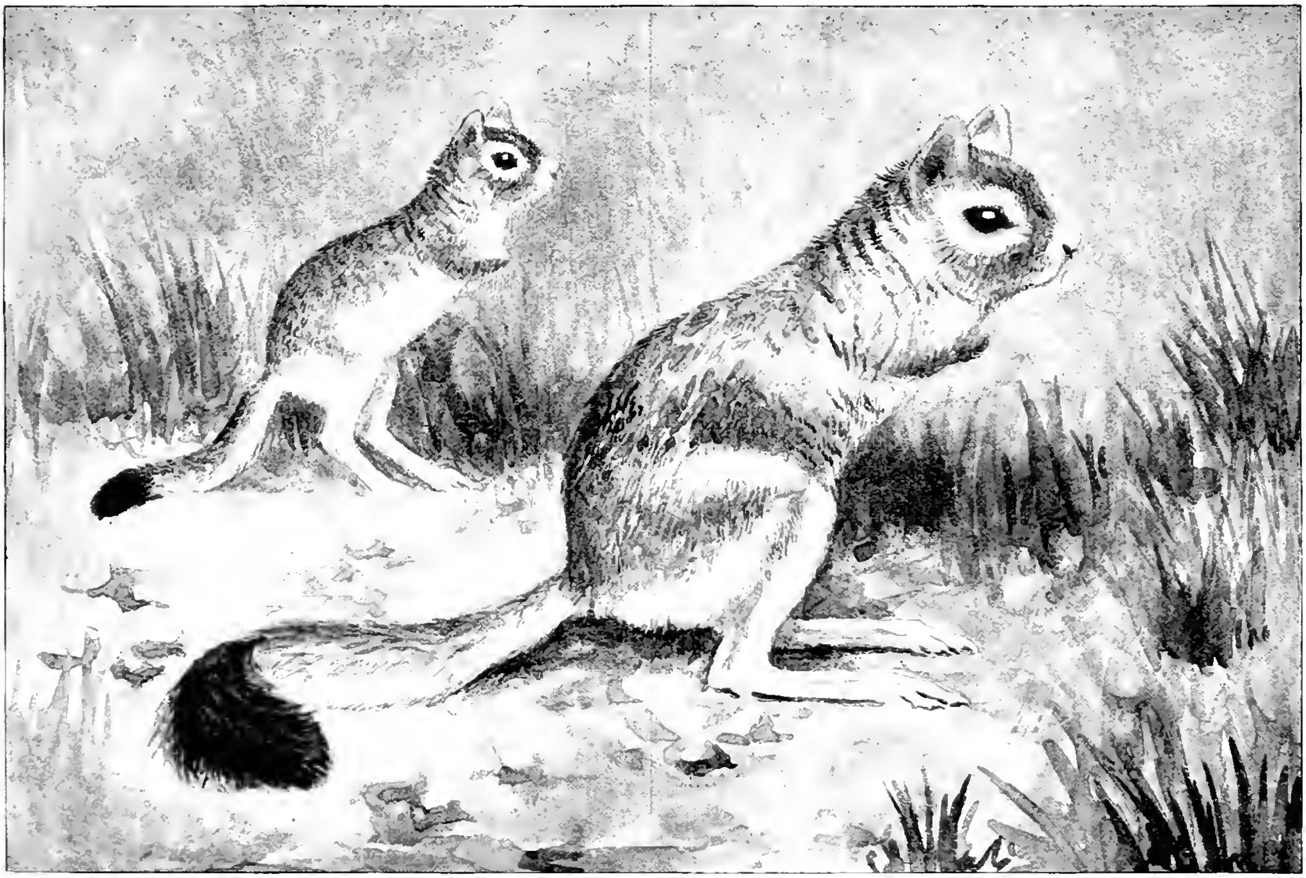
Rare Living Animals in London.

By P. L. SCLATER, Dr.Sc., F.R.S.

II. The Cape Jumping Hare,

(*Pedetes Caffer.*)

THIS is, indeed, a rare animal in London, and I believe that the specimen from which Mr. Goodchild has prepared the accompanying sketch is the only representative of the species that has as yet been brought alive to this country.



II.—The Cape Jumping Hare (*Pedetes Caffer*)

The "Jumping Hare" of the Cape Colony, the "Spring-haas" of the Boer farmers, is a well-known inhabitant of the high interior plains of South Africa, and has attracted the attention of travellers and settlers there from the earliest times. As long ago as 1778 it was described by the learned Russian naturalist, Pallas, as *Mus caffer*, and shortly afterwards Buffon, in the supplement to his "Histoire Naturelle," gave a fairly accurate account of it as the *Grande Gerboise du Cap*, from notes and sketches furnished to him by Forster. Other well-known authorities on South Africa who have written of it are Sparrman, Thunberg, Le Vaillant, and Burchell, the last-mentioned naturalist having carefully described it in his "Travels in the Interior of South Africa," from observations made in Griqualand West, where, at his time, it was by no means uncommon.

The general colour of the Jumping Hare is tawny brown, becoming paler on the sides and almost pure white beneath. There is also a well-marked white stripe on the body in front of the thighs. The eye is large and the ears are rather long and somewhat pointed; they are thickly clothed with hairs at the base, though nearly naked at their upper ends. The fore-limbs are short, with five pointed toes which are usually carried close to the body and are not very perceptible in the ordinary attitude of the living animal. The hind legs are strongly developed and much lengthened, the tarsus being as long as the foot from the knee to the ankle. There are only four toes to the hind-limb, of which the third is the longest, and all are armed with solid hoof-like nails. The tail is nearly as long as the body (about 20 inches), and is covered with long hairs; it is brown above and paler beneath, with a large terminal black patch.

The Spring-haas is nocturnal, or, at any rate, crepuscular, in its habits. It lives in small communities on the open veldt, both in the plains and in the mountain-ranges, and makes large and deep burrows in the ground, whence it emerges towards sunset, being rarely seen in the bright daylight. When chased in the open it proceeds in great bounds like a Jerboa or kangaroo, for which its highly-developed hind legs are admirably adapted, and it is even said to move faster up hill than down. Its food is entirely of a vegetable nature, and consists of roots and green stuff of all sorts. Its flesh, according to Le Vaillant, is very good to eat, and in his days was much appreciated by the Hottentots and Caffers.

The Jumping Hare is widely distributed over the open districts of South Africa. In his recently-published work on the Mammals of the Cape Colony and adjacent lands, Mr. W. L. Sclater tells us that it is found throughout the higher and drier districts of the country, extending northwards to Angola on the west, and the Transvaal and Rhodesia on the east, but not apparently occurring in Nyasaland or Mozambique. The South African Museum contains examples of this animal from the Port Elizabeth, Albany, Graaf-Reinet, and Middelburg Divisions of the Cape Colony, and Mr. Sclater states that it is also found throughout the Orange River Colony, the upper part of Natal, Griqualand West, Bechuanaland, and German South-West Africa.

The Spring-haas is very rarely met with in captivity. As already stated the specimen now figured is, I believe, the only one ever brought to England alive, although I have once seen an example in one of the Continental Zoological Gardens. The Zoological Society's specimen was presented to them in 1898 by Mr. William Champion, F.Z.S., of Durban, Natal, and received at the Gardens on March 31 of that year. It has lived in good health and condition ever since, but is rarely to be seen outside of its box in the day-time, unless the keeper be specially summoned to exhibit it.

The Spring-haas has been arranged by some authors among the Murine Rodents and by others near the jerboas, to which it exhibits much superficial resemblance. But there is no doubt that its strongly-marked characters require it to be placed in a family by itself, and Mr. Oldfield Thomas, who has recently published a general revision of the Order Rodentia, has put the Pedetidae at the commencement of the Hystricomorphine series, which is probably its most natural position. Mr. F. G. Parsons, the author of an elaborate essay on the anatomical structure of *Pedetes* in the Zoological Society's "Proceedings" for 1898, has come to nearly the same conclusion.

PROFESSOR JOHN MILNE has made the suggestion that the displacement of position of the earth's poles, which is of an irregular kind and which can be traced to no known law, may be due to movements of the earth's crust, and that, therefore, the magnitude of the change in position of the poles might be expected to correspond in some way to the number and frequency of great earthquakes. This theory has been reviewed by M. A. de Lapparent, who was the French secretary at the recent International Congress of Academies, in an article entitled "The Wandering Poles," and he finds that the measurements made by the Meteorological Institute at Rome, under M. Cancani, corroborate the Milne conclusions in a remarkable way. Since great earthquakes and earth tremors result apparently from movements that take place in the earth's crust—an ocean bed sinking or a continental mass rising—it seems natural that this factor should contribute effectively to the change and distribution of terrestrial mass, and should, consequently, affect the position of the earth's axis, conjointly with the annual exterior causes. If this conclusion be a correct one, then by observing astronomically the irregularity in movement of the earth's poles we should be supplied with a means of auscultating the variations in the crust of the earth. The science might almost be called the new astrology, since we might perceive in the apparent motions of the stars cataclysmic action, possibly of direct influence on man's destiny, on the earth.

The Later History of the Horse.

By R. LYDEKKER.

IN the January number of *Knowledge* I gave a brief sketch of the gradual evolution of the specialised, single-toed, modern horse—or, rather, of all the members of the genus *Equus*—from earlier three-toed and four-toed mammals of a more generalised type of bodily structure. In that article only a single short paragraph was devoted to the special origin of the domesticated horse, lack of space preventing this important, although exceedingly difficult, aspect of the subject from receiving the attention it deserves. In the present article it is my intention to discuss somewhat more fully the little that is known concerning the history of *Equus caballus*, as the domesticated horse and its immediate wild relatives are termed by naturalists.

During the late prehistoric, or Neolithic, period, when primeval man had replaced the rude chipped flint implements and weapons of his Palaeolithic forefathers by a more advanced type, in which the surface was ground smooth and polished, as well as in the Palaeolithic period itself, horses are definitely known to have been exceedingly common throughout Western and Central Europe in a wild state. This is fully attested by the abundance of their skulls, teeth, and bones in the superficial deposits of this country, such as the turbary of the Lea Valley near Walthamstow, and a gravel-bed at Audley End, and in numerous caves on the Continent, like that of La Madelaine in France. Although attempts have been made to distinguish two species of true horse from the prehistoric deposits, it seems practically certain that all the remains are inseparable from *Equus caballus*, as typified by the ordinary domesticated horse of North-Western Europe. Careful examination of all available fossil skulls—that is to say, of the specimens in the British and other London museums, as well as the figures of those from Continental localities given in scientific works—indicates, moreover, that the Neolithic and Palaeolithic horse agrees with the ordinary modern breeds of Western Europe in the complete absence of any remnant of the depression in front of the eye for the reception of the face-gland or larmier, which forms such a distinctive feature in the skulls of their early Pliocene three-toed ancestors, the Hipparions, and of which a distinct trace persists in their probable immediate progenitor, the extinct *Equus stenonis* of the later Pliocene epoch of this country and the Continent.

Their semi-fossilised skulls and skeletons represent, however, by no means the whole of what we know concerning the prehistoric horses of Western Europe. Primitive man, as represented in this particular instance by the cave-dwellers of La Madelaine, was, fortunately for us, something of an artist, albeit of an extremely "pre-Raphaelite" type, and has left us crude, although unmistakable, sketches of several of the contemporary mammals he was accustomed to hunt or tame, among which are some of the horse. In the main, these rude sketches of the prehistoric horse present a very strong general similarity of type, and portray a clumsy-headed and short-limbed brute, with an upright or "hog" mane, and a rough tangled tail, which was probably only sparsely haired near the root. A couple of sketches of this type are reproduced in figure 1.

Such Neolithic and Palæolithic horses were evidently very closely allied to the tarpan, or wild or semi-wild horses, which a century ago abounded on the plains of Southern Russia; a nearly allied type still apparently surviving in the form of the wild ponies—the so-called

Fig. 1.—Horses sketched by the Cave-dwellers of La Madelaine.

Przewalski's horse—of the borders of the Gobi desert, which seem to be, at most, nothing more than a local wild or half-wild race of the domesticated horse. In these animals the mane is upright or slightly falling over at the summit, the tail is thin and scantily haired at the base, while the head is heavy and ass-like, and the limbs are short. In colour the Mongolian ponies are dun, with dark brown manes, tails, and legs, and frequently with the muzzle whitish; but the tarpan seems to have been a mouse-coloured animal. Probably the prehistoric horse was very similar in colour to one or other of the two.

Although most of the sketches of the contemporaneous horse left by primitive man indicate animals of the type referred to above, it should be mentioned that a few of these sketches show a somewhat different form; and from this fact it has been suggested by some writers—among them Professor R. Munro,* of Edinburgh, who has lately written on this subject—that two distinct forms of ancient wild horse are recognisable in Western Europe, the one having a smaller head and longer limbs than the other. In some instances we must probably attribute these differences in the sketches of the ancient horse to incapacity on the part of the artist; and this for two reasons. In the first place, none of the skulls of Neolithic and Palæolithic horses that have come under my notice exhibit any differences of the above nature; and, in the second place, judging from what obtains among mammals at the present day, it would be in the highest degree improbable that we should have two closely allied species of true horse inhabiting the same locality contemporaneously. If, on the other hand, we credit the artist with having given correct portraits of two distinct types of true horse, then it is practically certain that the animals he portrayed were domesticated. It should be mentioned, however, that a sketch from the Kesslerloch Cave, Switzerland, which has been taken to represent a second species of true horse, is probably intended for the wild ass.

The question as to whether the horse was or was not domesticated by the Palæolithic and Neolithic hunters of Western Europe is one very difficult to answer. From the abundance of its remains in the neighbourhood of stations occupied by contemporary man, it seems well-nigh certain that during the periods in question the horse formed an important article of food; and it has been a natural inference that the animal was kept in a domesticated state by the primitive hunter, as well as pursued for the sake of its flesh. Sir William Flower, for instance, wrote as follows:—

"These horses were domesticated by the inhabitants of Europe before the dawn of history. Cæsar found the ancient Britons and Germans using war-chariots drawn by horses."

This view Professor Munro, in the article already cited, refuses to accept; his opinion being that the horse was never domesticated by the Palæolithic and Neolithic hunters of Western Europe. This opinion is largely based on the rarity of the remains of this animal in English "barrows," or tumuli, as well as in the waste-heaps of the ancient Swiss lake-dwellers. It is also urged that the absence of portraits of mounted men among the sketches left us by the cave-dwellers points to the same conclusion.

To the latter objection I do not think much importance can be attached. The rarity of horse-remains in the tumuli, etc., may be fully admitted as an undoubted fact; but since horses, at least on the Continent, seem to have been used for food at this period, the absence of their bones is, perhaps, just as remarkable whether they were known only in the wild state, or in both the wild and domesticated condition. Here it may be remarked that in "Prehistoric Times," Lord Avebury observes "that the horse was very rare, if not altogether unknown, in England during the Stone age." This, I take it, applies only to the domesticated breed, since it is quite certain that the animal existed in a wild state in Britain at this time. Nevertheless, the sentence is apt to be somewhat misleading, and it is for this reason that it is quoted.

An argument in favour of the domestication of the horse in Western Europe has been drawn from certain sketches found in Continental caves, which have been supposed to represent this animal bitted and bridled. As to the value of this evidence, I do not feel competent to offer an opinion, but I doubt if it can be dismissed by the suggestion (of Professor Munro) that these sketches may depict wild horses being led in halters or lassoes to the home of their captors for slaughter as food. If they be bridled horses at all, I think there cannot be much doubt that they were domesticated. My opinion with regard to the supposed two types of

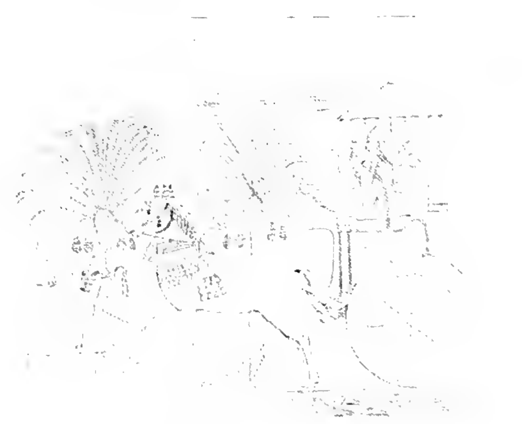


Fig. 2.—Hog-maned Horse from a Grecian sculpture.

horses represented in other sketches has been already expressed.

Another important point in this inquiry is how we are to account for the origin of the domesticated horses possessed by the ancient Britons and Germans in

* "On the Prehistoric Horses of Europe, and their Supposed Domestication in Palæolithic Times." Proc. R. Phys. Soc. Edinb., 1903, pp. 70-104, pl. i.

Cæsar's time unless they were the descendants of the native prehistoric breed; for it seems scarcely likely that the Britons, at any rate, could have imported a foreign breed. Unfortunately, we know nothing whatever with regard to the physical characteristics of these horses. If the ancient British war-horse were an animal of the type depicted in the Madelaine sketches, there would be little doubt as to its being an indigenous breed, for, as I shall show directly, the domesticated horses of South-Eastern Europe and Western Asia belonged to a long-maned breed of great antiquity.

What we, in fact, really want to know is whether naturally hog-maned horses of the tarpan type were ever domesticated in Europe; and to this question there seems, unfortunately, no possibility of giving a decisive answer.

It has, indeed, been suggested to me that the hog-maned horses represented on the frieze of the Parthenon, which was completed in the year 438 B.C., and those on the so-called Amazons' Sarcophagus, dating from the first century B.C., are animals of this type. And since at least most horses in Greek sculptures from about the year 500 B.C. to the Christian era display similar hog-manes, the suggestion appears at first sight very

Fig. 3.—Long-maned Horses of the Assyrian countries. (From Layard's "Nineveh.")

plausible. I am informed, however, by Mr. Cecil Smith, of the British Museum, that until about the year 500 B.C. the Greek horse is represented with a long flowing mane. About the latter date, or, perhaps, a little earlier, Athenian vases begin to show horses with hog-manes, after which such a type becomes predominant, if not universal, in the sculptures. Etruscan vases, on the other hand, generally show long-maned horses. From this, I think, it is perfectly evident that the short manes of the horses on the Parthenon frieze and other Græco-Roman sculptures are the result of cutting. It follows from this, on the assumption that a long mane is the result of domestication, that the Greek and Etruscan horses belonged to a very ancient breed.

If, now, we direct our attention to the sculptures of horses from Nimrod, Persepolis, and other ancient cities of Western Asia, as shown, for instance, on pages 224 and 225 of Vaux's "Nineveh and Persepolis" (1850), and on the plate facing page 334 (herewith reproduced) of the abridged edition of Layard's "Nineveh," we find that they all have long flowing manes, and tails of such length as to be, in some instances, looped up. These horses, moreover, appear to be of a finer and more Arab-like shape than those in the Greek sculptures. A similar type of mane and tail is displayed in some of the horses depicted in the ancient Egyptian frescoes, as in the one representing the "Tribute of the Arvadites" given on page 67 of Gosse's "Ancient Egypt" (1847). Here the whole shape and make of the horse is decidedly of the Arab type. In some of the other figures of horses in the work last mentioned, as those on page 108, the pendent character of the mane is not so unmistakably displayed, although I think it was the artist's intention to represent this type.

As to the date that horses were introduced among the Babylonians and Assyrians, there does not appear to be any definite record; but from the fact that in the sculptures the horseman when going to war is always represented with an attendant on foot leading his horse and carrying one or more of his weapons, it has been suggested that riding was a comparatively new art. In Egypt the evidence is more satisfactory, as the horse is not represented on any of the frescoes antecedent to the 18th dynasty (about 1900 B.C.), after which it gradually becomes more numerous. In all these instances, it may be observed, the horse is invariably used only for war, or in state processions—never for drawing burdens or in agricultural operations.

The ancient Egyptians doubtless received their horses from Assyria and the Babylonian countries. As to the origin of the Assyrian and Babylonian horses, some difference of opinion has prevailed, but it appears to me most probable that they came from some part of Central Asia, such as the Turcoman countries. They certainly were not derived from Arabia, where the horse is definitely known to have been a comparatively recent introduction. Neither, I think, was Africa the place of origin, as has been suggested by some, for the very sufficient reason that we have no evidence of the existence on that continent of either wild or half-wild true horses at any period.

From the foregoing it would appear that we have decisive evidence of the existence in Egypt so long ago as 1900 B.C., and in the Assyrian countries (if the above inferences be correct) at a considerably earlier period, of a long-maned breed of Arab-like horse totally unlike the wild tarpan or the prehistoric horse familiar to the cave-dwellers of La Madelaine. Such a breed must have been the result either of a long antecedent domestication, or must have been produced from a wild species furnished with a long mane and tail. Probably the former view is correct so far as the development of the mane and tail is concerned, although, as shown below, it is most likely that the breed traces its origin to a species distinct from the tarpan and prehistoric horse of Western Europe.

That such a breed should have been introduced into Germany and Britain in pre-Cæsarian times—at all events, in such numbers as to obliterate all traces of crossing with the wild horses which abounded in those countries during that period—seems to me in the highest degree improbable; and I therefore cannot at present see any valid reason for refusing to credit the view of Flower that in Palæolithic and Neolithic times the indigenous hog-maned wild horses were domesticated by the aborigines.

When advocating this view, Sir William was, however, careful to add that it is "doubtful whether the majority of the horses existing now are derived directly from the indigenous wild horses of Western Europe, it being more probable that they are the descendants of horses imported through Greece and Italy from Asia, derived from a still earlier domestication, followed by gradual improvement through long-continued attention bestowed upon their breeding and training."

In other words, this, broadly speaking, is equivalent

to saying that at some early period a breed of long-maned horses was introduced from the east into Europe, which resulted in so modifying the original hog-maned stock as to render flowing manes universal; and if this be the case, we have to attribute a mixed, or dual, origin to the ordinary, or so-called "cold-blooded" horses. Traces of the indigenous blood may, perhaps, be detected in the apparently stouter build of the horses of the Greek sculptures as compared with those of the Egyptian frescoes and Assyrian bas-reliefs.

In comparatively modern times another importation of eastern blood is definitely known to have taken place, which, by careful restriction, has resulted in the production of the existing thoroughbred. The Arabs and Barbs from which this thoroughbred strain originated were themselves, in all probability, the direct unmixed product of the aforesaid long-maned horses of ancient Assyria, Babylonia, and Egypt, which we have seen reason to believe arose from a totally different stock to the hog-maned breed of Europe.

With regard to the ultimate ancestor of the thoroughbred and its early Asiatic progenitor, opinions differ. Professor Ridgeway,* of Cambridge, has recently suggested that Grévy's zebra (*Equus grevyi*), of Somaliland and North-East Africa, is the probable ancestor of the thoroughbred stock. Such a solution of the question will not, however, I venture to think, commend itself for a moment to competent zoologists, and I need not, therefore, attempt its refutation.

From the occurrence in a horse-skull of eastern origin in the British Museum of a remnant of the cavity for the face-gland of the Hipparions, and of a fainter trace of the same in the skull of the thoroughbred "Bend Or," I have been led to suggest that the thoroughbred and eastern breeds generally may be derived from an extinct Indian species—*Equus sivalensis*—in which this face-gland was comparatively well developed; and that, as might have been expected, eastern horses retain traces of the face-gland cavity, which, as we have seen, has been completely lost by the prehistoric horses of Western Europe, as it is by their presumed cross-bred existing descendants. It must be confessed that the evidence in favour of this theory is at present slender; and the examination of a series of skulls of Arabs and thoroughbreds is necessary to test its probability. As it is, all that can be said in its favour is that it affords a working hypothesis which accords well with the facts.

In conclusion, I may mention that a correspondent has informed me that a few years ago he owned a horse which showed distinct external traces of the face-gland, in the form of a well-marked depression in front of each eye. The horse referred to was believed to have been an Argentine, and if this be true, another very curious point arises. Certain extinct South American horses, constituting the genus *Onohippidium*, are characterised by the enormous size of the cavity for the face-gland, which was no doubt functional. From the condition of their remains they certainly lived till a comparatively recent date; and it is possible they may have survived till the Spanish exploration of South America, for if the horses seen in Argentina by Cabot in 1530 were indigenous (and it is very difficult to understand how they could have been introduced), they must certainly have been Onohippidiums. Could my correspondent's horse have been one of their cross-bred descendants?

* "The Origin of the Thoroughbred Horse." Proc. Cambridge Phil. Soc., vol. xi, pp. 141-143 (1903).

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Reversal Further Considered.—There is no room for doubt that the developable condition is of a more complex character than it is often supposed to be. Sir William Abney showed some years ago that the result was not uniform, although the time of exposure multiplied by the intensity of the light was constant, if the light intensity varied—that is, the result of the action of an intense light for a short period is not the same as that of a weak light for an equivalent longer time. The action seems to me to be comparable to the difference between the few blows of a heavy hammer and the many blows of a light hammer, though I do not wish to suggest that the analogy is complete. The different effects produced by various forms of radiant and other energy are more especially noticeable when the action is allowed to proceed beyond what would produce a normal result, or when one kind of energy is allowed to follow another. Professor R. W. Wood has distinguished five "types" of reversal (better, perhaps, called *methods* of reversal), namely: (1), ordinary over-exposure, the same light being allowed to continue to act; (2), reversal produced by developing the plate while it is illuminated by lamp-light or feeble daylight; (3), the result of exposure for a minute or two to light between developing and fixing; (4), the Clayden effect, a longer feeble exposure following a short intense exposure; (5), reversal produced by treating an exposed plate with a solution of a bichromate containing nitric acid, drying, and fogging by exposure to candle-light before developing. Professor Wood also found that Rontgen rays prevent the reversal of spark images by candle-light, that is, they negative the Clayden effect; but that the normal effect of Rontgen rays can be reversed by lamp-light. He arranges the following methods of producing the developable effect in order: (1), pressure marks; (2), Rontgen rays; (3), light shock (that is, an intense light acting for a short time, one-thousandth of a second or less); (4), lamp-light; and finds that any one can be reversed by subsequent exposure to any other that follows it in the list, but not by any that precedes it. Mr. Skinner has since observed that radium will reverse electric spark images (analogous to the Clayden effect), and by prolonging the exposure actually obtained a re-reversal. It has been stated that the continued application of Rontgen rays will not produce reversal. I do not know of any record of reversal produced by pressure. Perhaps the first three methods of producing the developable effect given above are unable to cause reversal of the normal result produced by each respectively. We want an experimental investigation of these and similar matters made under more definite conditions than any that have yet been published.

An Effect of Colour Screens.—A question that has been mooted occasionally, is as to whether a colour screen causes the light that it transmits to produce a greater effect (in the production of a developable image) than the same light would without the screen, when for example, the spectrum is photographed. General Waterhouse recently stated that he had found a chrysoidin screen to apparently confer greater sensitiveness to red than the unscreened plate showed.

Now, according to Professor R. W. Wood, the Clayden effect does not depend on wave-length, but only on time and intensity. It is, however, quite likely that the red screen prevented a feeble general illumination of the plate, and it appears possible that in this way it stopped a certain reversing effect, and so caused the plate to appear more sensitive to the red light. The various results produced by different causes, as detailed above, justify such a suggestion.

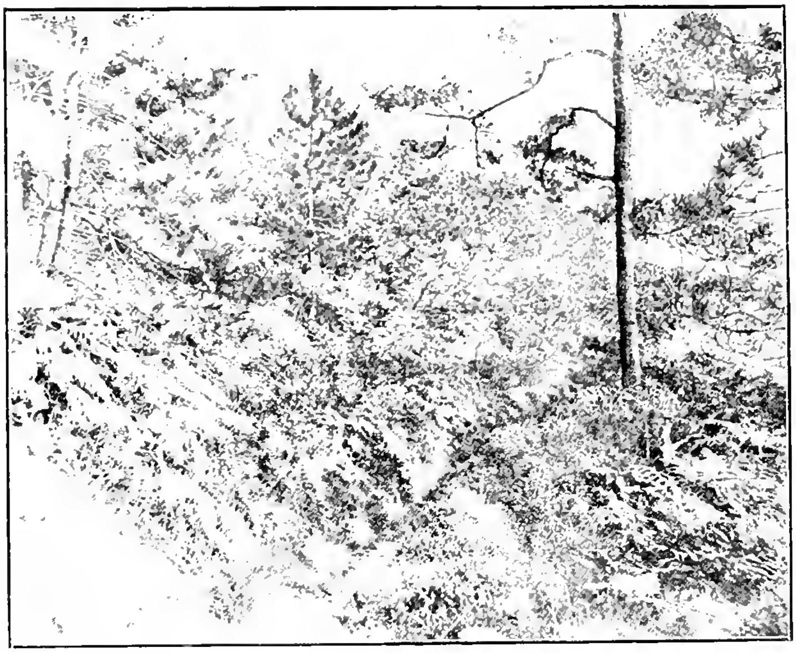
What is Reversed?—One may well ask what is it that is reversed and what is it that is changed in all these experiments? Silver bromide, silver iodide, gelatine, and often potassium bromide are present in the film. It has been suggested, I believe, that there is some occult combination between the gelatine and the silver salts, but there does not appear to be any evidence to support this notion. It has long been known that silver iodide retards the reversal of silver bromide, and this is probably the chief if not the only reason for its introduction into commercial plates. If all the experiments on exposure-effect and reversal referred to were made on plates of known composition, including simple gelatino-bromide films, we should certainly get more information than we have. A given commercial plate is not always the same. All makers strive to improve, and improvement means change. I think, too, that there is very good reason for doubting Professor Wood's time-limit of about one-thousandth of a second for what he calls the "light-shock" effect. Different illuminants and different plates might give other time-limits. My own results that I described last month, obtained by the use of Wynne's shutter-speed tester, indicate that a modification or amplification of Professor Wood's deductions from his experiments is necessary. All the experiments and results here referred to must be regarded as only initiatory.

Ever-Set Shutters.—An "ever-set" shutter has the obvious advantage that it is always ready for use, and that is really the meaning of the word invariably used to describe such apparatus. It would, however, be rather more correct to describe them as never-set, for when an exposure is made the shutter is not released, but the whole movement of the parts that move is effected by pressing the trigger or pinching the ball. The closing is generally effected by springs, in which case the opening has to be done against the pull of these springs. Other things being equal, therefore, an "ever-set" shutter requires more force to operate it than one that is set by a separate operation and merely released for the exposure. If the camera is held in the hand this extra force required means more risk of movement, and if a pneumatic ball is used when the india-rubber or its connections are in a poor condition, it means more risk of failure to operate the shutter. But as is general in such cases, it would be wrong on this account to condemn "ever-set" shutters as a class, for as a matter of fact some of them require very little force to operate them, less, probably, than the force needed to release some of the shutters that are "set" by a separate movement. But the fact remains that the same shutter working under the same conditions will need less force to release it when it is previously set than to operate it without the previous setting.

Peat and its Mode of Formation.

By F. E. FRITSCH, B.Sc., Ph.D.

WHENEVER plant-remains are deposited at a rate which exceeds the rate of decomposition, we get a mass of semi-decayed vegetable substance of a brownish or blackish colour and of soft consistency, which we call peat. Several conditions are necessary to admit of such a deposit being formed, the most important being insufficient drainage (*i.e.*, accumulation of more water than is removed) and lack of the ordinary rapid agents of decomposition. The silting up of a river or of a lake, or the destruction of an area of forest, may both lead to the formation of a swamp, which gradually becomes firmer and drier by the advent of marsh-plants;

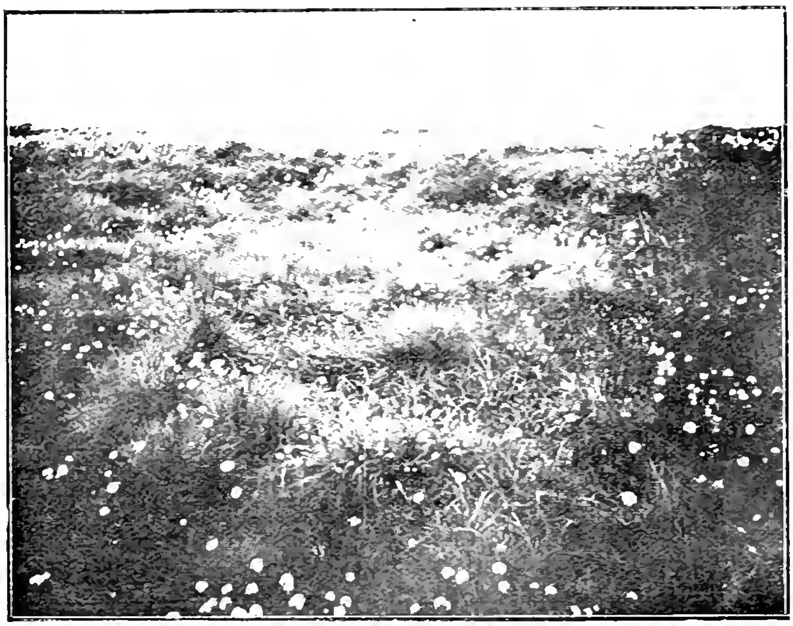


Upland Wood. Heather and Bilberry growing in Peat formed in the Wood.

as their remains accumulate a layer of peat is slowly formed. Under ordinary circumstances all plant-remains are rapidly decomposed by the various organisms occurring in the soil—mainly bacteria, but moulds and a number of animals also take some part in the process. This decay is especially rapid in warmer climates, inasmuch as the growth and activity of the above-mentioned organisms is much increased at higher temperatures, and, consequently, peat is almost unknown in the tropics. In colder regions, however, an abundant vegetation, together with incompetent drainage, is generally too much for the agents of decomposition and, when a layer of peat has once originated in this way, the process goes on more and more rapidly owing to the antiseptic action of the organic acids, formed by the partial decay of the vegetable substance.

Mr. C. E. Moss has recently published an interesting study of the peat moors of the Pennines. A large portion of the summits and slopes are occupied by such moors, which are quite wanting, however, on the steeper slopes, leading down to the lowlands. Three different

types of these moors can be distinguished according to the characteristic plants which grow on them; of these the cotton-grass moors are by far the most extensive with a vegetation in which one of the two species of cotton-grass (*Eriophorum vaginatum* and *E. angustifolium*) are the prominent forms. The other two types of moors occur round the edges of the first, one type being characterised by the abundance of heather (*Calluna Erica*), the other by the essentially grassy character of its vegetation. The cotton-grass moors are richest in peat, which here extends to a depth of 10, or even 20-30 feet, whilst the other two types of moor are much poorer in peat, which is usually not as much as five feet in thickness and often very inconsiderable. When we come to inquire into the origin of these peat-moors, all the evidence seems to point to their being due to the destruction of an original forest. Numbers of place-names occur on the Pennine slopes



Cotton-grass Moor in June. Cotton Grass in Fruit.

which indicate a forest, although the only trace of it, to be found now, lies in the buried timber, which has been found enclosed in the peat. Probably the Roman invasion was the cause of the destruction of a great deal of this primitive woodland, and the fallen logs probably served to dam up a number of the streams, which arose on the hills, and to otherwise interfere with the drainage. The resulting swamps would readily become populated by bog-forming mosses (*Sphagnum, Hypnum*), which are always present in the upland woods, whilst the previously existing vegetation would soon be smothered. From such marshy centres the bogs would spread out in all directions and probably even come to occupy ground which was even primarily devoid of forest. After some time the remains of the mosses will have formed a sufficiently consistent layer for the establishment of typical marsh-plants, such as the cotton-grasses mentioned above, and so the entire development of such a peat-moor can be traced. On the slopes of the Pennines the better drainage will not have admitted of such peat-formation, and, consequently, the original forest has here again been more or less re-established. On many of the limestone rocks, which emerge from the peat, a thin layer of this latter is found, and here it may actually be seen in process of formation. The necessary moist basis for the settlement of mosses is in these cases given by a layer of blue-green or green Algæ of a slimy consistency or by the growth of small Lichens. The mosses grow rapidly and form a thin layer of peat of a dry character, on which a slightly divergent flora is usually developed.

The above-described method is no doubt not the only way, in which extensive peat-areas may develop, for the silting up of any fair-sized area of water will, given the suitable conditions, lead to the formation of an extensive moor, and it is by no means necessary that the silting up should be caused by the destruction of woodland. There seems, however, no doubt that the Pennine moors owe their origin to such a cause, and it would be no insuperable difficulty to reverse matters and again let forest cover their slopes. At the present day the huge area of peat is quite neglected, and there appears not to be a single peat factory in the whole district.

ALUMINIUM does not readily lend itself to plating, because the plated metal tends quickly to scale off, and the defect has been attributed to the microscopically thin film of oxide which forms on the surface of the aluminium. A new method of dealing with the metal is to immerse it in soluble fluorides, together with some free hydrofluoric acid; and thus not only to remove the oxide film but to prepare the surface of the aluminium for the reception of a plate of other metal by roughening its surface. The aluminium is then quickly rinsed and immersed in a bath of zinc and aluminium sulphates, and while in the bath a film of zinc is deposited on it by the ordinary methods of electro-plating. Other metals may now be plated on the zinc. An electrolytic film of gold will, however, disappear in the zinc, so that if it is required to give a gold plating to the aluminium-zinc surface this surface must further be coated with copper.

THE German physicist, Dr. Guillaume, has discovered a new alloy, which he has named Invar. This peculiar product is formed of certain proportions of nickel and steel and has the ability to withstand heat without expansion. When made in a certain way it even contracts slightly on being heated. Its importance is easily seen when it is considered that all instruments of precision suffer errors from changes in temperature. Measuring apparatus, and particularly time-pieces, will be greatly benefited; the ability to make a pendulum certain to stay of a constant length, regardless of thermal influence, will be regarded with enthusiasm by astronomers. Other uses have already been found for it, particularly in surveying apparatus. If it is sufficiently reliable to replace the ice bars used in triangulation work, it would effect a great saving in time and money.

The "Panorama" Military Telescope.

By Dr. Alfred Gradenwitz.

The field of view of a telescope is necessarily limited, and whenever the observer wishes to inspect the whole of his horizon, he is compelled to turn round his whole instrument, while his body has to follow this rotation.

This drawback is obviated in the so-called "panorama" telescope, where the desired range of

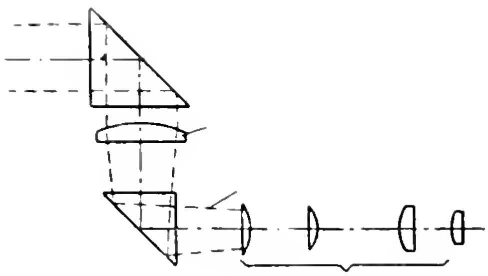


Fig. 1.

vision is secured whilst the eye-piece part of the instrument may remain immovable. It is obvious that the necessary condition for practical use will be that, apart from the magnification produced by the instrument, the observer should receive the same impression of the horizon as if he viewed it with the naked eye. If, therefore, an ordinary telescope, either terrestrial or astronomical, were arranged as represented in figures 1 and 2, with a total reflection prism turning round its

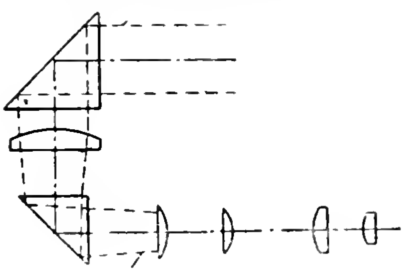


Fig. 2.

vertical axis in front of the objective, in order to obtain the panorama effect, the image produced would undergo an angular distortion equal to the angle of rotation. Anything placed on the top in figure 1 would, after a 180° rotation of the reflection prism, appear to lie below; the image thus being turned also by 180°. The prism combination to be chosen for the internal optical construction of the panorama telescope had, therefore, to fulfil the following conditions:—

1. The image should be erected, simple astronomical eye-pieces being used instead of the awkward terrestrial eye-pieces.

2. The image, whilst exploring the surrounding horizon, should be kept in position, presenting itself to the observer as it would appear to the naked eye looking around.

The Goerz firm has designed several types of panorama telescopes, and the one described below was especially intended to be used as a *pointing telescope* in connection with guns. The optical elements of this combination are shown in figure 3, where A is a total reflection prism, B the erecting prism, C the objective, D a prism separately represented in figure 4, and O an astronomical eye-piece.

The rays from the object, penetrating the prism A, are deflected downwards into the prism B, erecting them in one direction. After traversing the objective C, the prism D will produce a lateral change as seen from figure 4. The image of the object is, therefore, produced at the centre of the eye-piece diaphragm E, in a position corresponding to reality, where it is viewed through the astronomical eye-piece in enlarged size.

The prism B has a square cross section, an important feature being the fact that a rotation by 180° around its longitudinal axis will result in the image being turned by 360°, the image thus rotating at twice the angular speed of the prism. In order, therefore, to obtain an image corresponding to nature, the prism B should be made to follow the movement of the prism

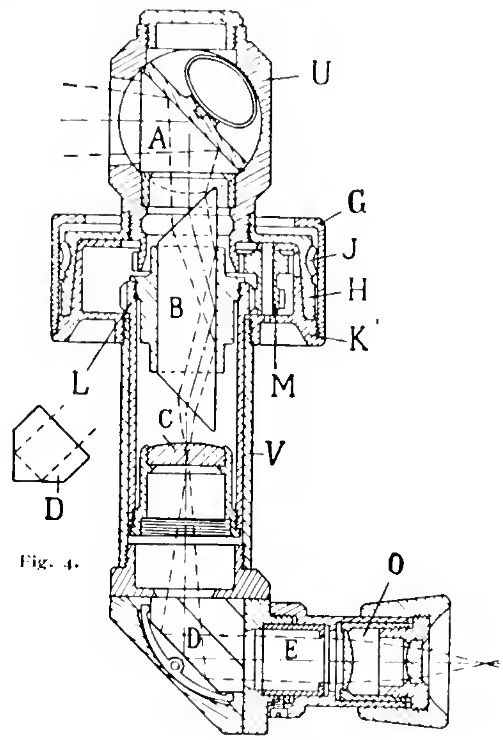


Fig. 4.

Fig. 3.

A at half its angular speed. To secure this effect, the latter is inserted into the casing U, being fitted below with a toothing and rigidly connected to the spiral drum H. The latter may be made to rotate on the box K, which is screwed inside to the casing V and outside to the cap G. In the casing V rotates the tube L, being also provided with a toothing at its upper end, and bearing at the top the framing which contains the prism B, and below the objective C. In the two toothings the double pinion M engages, the ratios of gearing being so designed as to impart to the tube L an angular speed of the same direction as that of the prism A and of half its value.

By acting on a screw solidly mounted in the cap G and engaging into the toothing J of the spiral drum H, the reflection prism A and accordingly the prism B, are turned round, thus producing in the field of view the characteristic panorama effect.

In the case of the panorama telescope being used from a protected observing stand, the immovable posi-

tion of the observer will enable him to choose an observing post of the smallest possible dimensions, thus decreasing the chance of its being destroyed by the projectiles of the enemy. It may be used as pointing telescope for guns in direct or preferably in indirect pointing.

The design of the telescope has obviously to be adapted to the special use it is intended for. While in a stationary observing post a relatively great field of view, a strong magnification, and high accuracy in reading the position of the optical axis are the most important factors, in the case of an instrument used as pointing telescope in connection with a field gun, dimensions as small as possible, light weight, and solid mounting of the lenses and prisms will be of the utmost importance.

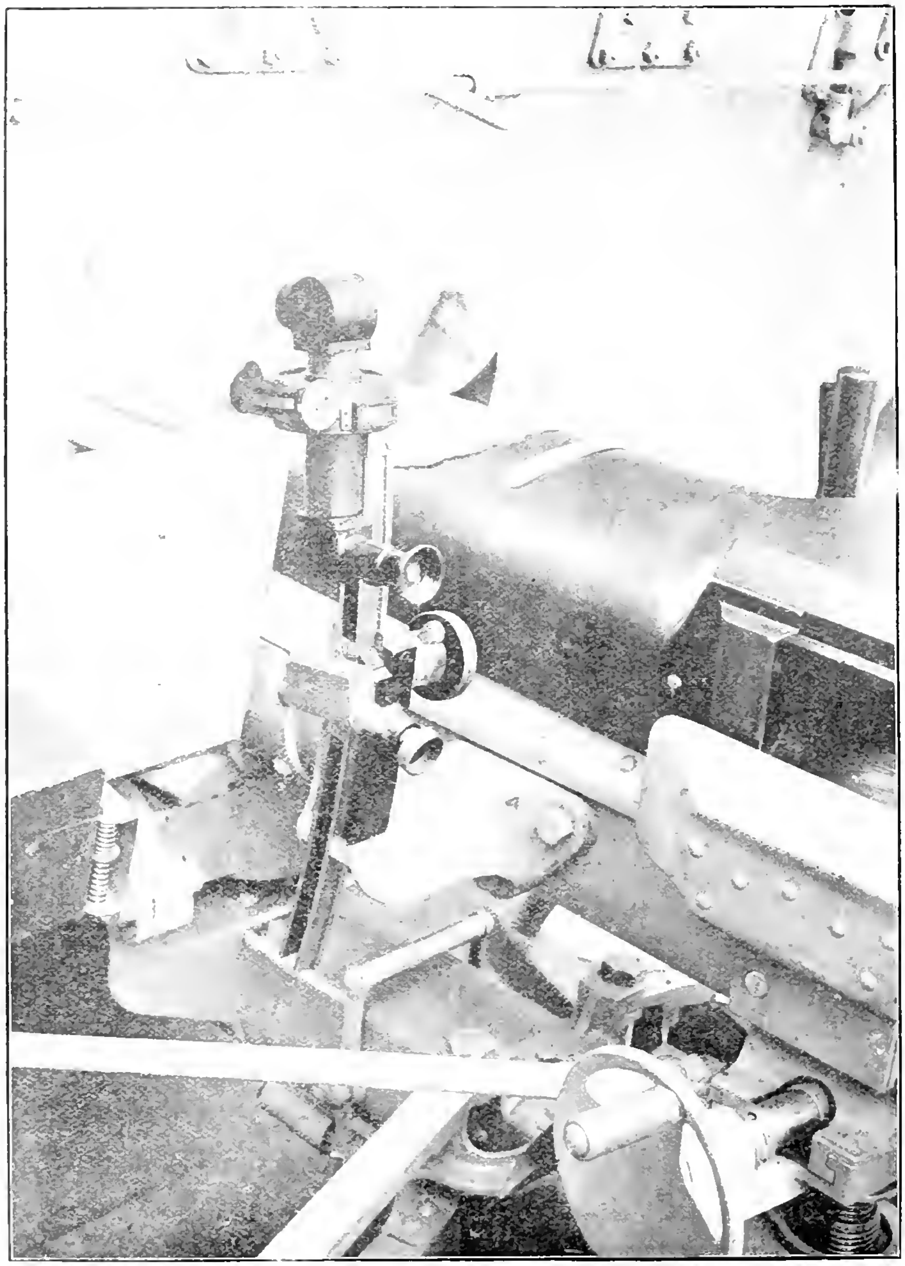


Fig. 5.—The Panorama Military Telescope.

Modern Cosmogonies.

By Miss Agnes Clerke.

IX.—The Inevitable Ether.

Ether is the fundamental postulate of physics. Its existence, nowise apparent, is in all manner of ways implied. The properties that must be assigned to it are, indeed, arduous of conception. We need the aid of forced analogies to enable us to realise, even imperfectly and indistinctly, the manner in which it discharges functions obviously somehow discharged. But in the last resort, everything is obscure; if our thought-borings go deep enough, they always reach the incomprehensible.

The original ether was the "quintessence" of the ancients—a kind of matter vaguely imagined as pure and incorruptible enough to serve for the raw material of the heavenly bodies, the four common elements being reserved exclusively for sublunary use. The distinction, however, eventually broke down. All the spheres, from the *primum mobile* to the very surface of our low earth, are pervaded by a subtle mode of action, demanding for its transmission machinery of a finer kind than could be constructed out of gross everyday matter. The phenomena of light, when they came to be attentively studied, imperatively required a medium, universally diffused, evasive to sense, accessible only by processes of reasoning. Hooke and Newton accordingly brought the ether through the Horn-gate of dream-land into a region of reality, where it became a subject of legitimate speculation to men of science. The task, however, of definitely specifying its qualities was not taken seriously in hand until the beginning of the nineteenth century, when the establishment of the undulatory theory of light supplied tangible holding-ground for ideas regarding the vehicle of transmission, and rendered the ether a fixture of thought.

A great deal is demanded from it. We cannot afford to set up an establishment of ethers; one factotum must suffice. Incongruous offices are devolved upon it. It has to be Atlas and Mercury in one. It is the universal supporter and the universal messenger. Whatever kind of influence, or form of energy, can pass from world to world, is conveyed by its means. If "action at a distance" be inadmissible (as Newton himself held it to be), the pull of gravity must be exerted through a medium; and common sense insists upon its identification with the transmitting medium of light and electricity. That its dictate is actually complied with is rendered virtually certain by Hertz's discovery that an electric explosion starts an undulatory disturbance indistinguishable, except in scale, from luminous waves; coupled with the indications derived from Mr. Whittaker's recent mathematical researches to the effect that a swifter beat of the same ethereal wings bears the mandates of gravity. The unity of the medium may then be regarded as finally ascertained; the complex interactions of sundry different "fluids" need no longer be taken into account. To provide one with the capabilities implied by the services we perceive it to render is, indeed, a sufficiently formidable task.

In popular apprehension, the ether of space figures as a finer kind of air. No idea could be more misleading. The elasticity by which air transmits the longitudinal waves of sound is totally different from the elasticity by which ether propagates the transversal waves of light. Air yields to pressure; disturbance hence produces in it undulatory condensations due to oscillations of the gaseous molecules along the line in which the audible commotion travels. Ether, on the contrary, appears to be entirely incompressible; it conveys no vibrations directed lengthwise. Now this is extremely perplexing. We have no experience of a kind of matter absolutely rigid to pressure, while yielding, albeit with intense reluctance, to distortional stresses. A jelly-like solid makes the nearest, though a very distant approach to fulfilling the indispensable conditions; and a solid ether was accordingly in vogue until long past the middle of the nineteenth century. For a solid, it had very peculiar qualities; that, for instance, of offering no resistance to motion. It was, in truth, obviously a mere temporary expedient—a scientific fiction which might pass muster until replaced by something corresponding less distantly with the fundamental fact. At last, on the advent of the electro-magnetic theory of light and the modified conceptions which it brought in its train, the solid ether withdrew behind the scenes. Its properties, though inconsistent and unconvincing, had not been chosen arbitrarily; they were imposed by the necessities of the situation; and when these varied, speculators naturally had recourse to fresh inventions.

The most plausible is that of a medium neither solid, liquid, nor gaseous in the ordinary sense, but in the ideal state of a "perfect fluid." Out of such an ether, Lord Kelvin, with exquisite ingenuity, constructed his "vortex-atoms," which "had their day and ceased to be." Other ideas now prevail. "The present tendency of physical science," the late Mr. Preston wrote in 1890,[*] "is to regard all the phenomena of Nature, and even matter itself, as manifestations of energy stored in the ether." The more closely we look into the things around us, the more strongly the persuasion is forced upon us that what we call ether, electricity, and matter are really varied forms of one primal substance. Two comprehensive schemes of molecular physics, resting upon the basis of this unifying thought, have lately been elaborated, one by Dr. Larmor, the other by Professor Osborne Reynolds. They have nothing in common except the largeness of their synthesis. In every respect they are radically unlike, save in regarding the intangible ether as the one material actuality. Dr. Larmor, however, is not quite confidently explanatory. He presents no cut-and-dried theory of the universe; its haunting mysteries are not ignored in his efforts to rationalise them. Thus, he is vividly aware of the difficulties besetting the endowment of the ether with the type of elasticity which it is recognised to possess. He can only surmise that it results from particular modes of motion—from "kinetic stability" ensuing upon a special dynamical state. The medium may thus be thought of as pervaded by "a structure of tangled or interlaced vortex filaments, which might resist deformation by forming a stable configuration."[†] But the details of any such scheme of action are evidently far too intricate to be unravelled offhand; what concerns us here is to point out that no simple, structureless fluid can avail to maintain cosmical communications.

Dr. Larmor's conception of the ether, reduced to its lowest terms, is that of a "rotationally elastic medium."[‡] In other words, it resists being turned round an axis. The forces, however, continually acting upon it are of a gyratory nature; and hence arise strains, betrayed to our apprehension by electrical phenomena. Each "electron" is held to be the nucleus of some kind of distortion or displacement,[§] and carries with it, as it moves, a field of force. Out of these "point charges," material atoms are variously built up. They are "structures in the ether," encompassed by "atmospheres of ethereal strain," not—as they were formerly taken to be—"small bodies exerting direct action at a distance on other atoms according to extraneous laws of force."[¶] Obviously, the new view brings to the front extremely subtle questions regarding the nature of "dynamical transmission"[‖]—what the propagation of energy essentially consists in, and by what mechanism it is effected; and they are,

[*] *Theory of Light*, 2nd Ed., p. 28.

[†] *Encyclopædia Brit.*, Vol. XXV., p. 106.

[‡] *Report Brit. Ass.*, 1900, p. 626.

[§] *Aether and Matter*, p. 26.

[¶] *Nature*, Vol. LXII., p. 453.

[‖] Larmor, *Report Brit. Ass.*, 1900, p. 625.

for the present, unanswerable. Electricity is, on the theory we are attempting to sketch, positive or negative according to the direction of the originating strain. A positive electron might be imagined to resemble a spiral nebula of the right-handed sort, a negative one a left-handed spiral, or *vice versâ*. The analogy is, perhaps, fanciful; yet it helps towards obtaining a mental picture of objects which, insignificant and elusive though they appear, may be the initials and ultimates of this strange world.

The forces, at any rate, by which it is at present kept going are evoked *ad libitum* by the pioneers of modern research from the ethereal plenum. The actualities of matter are potentialities in the ether. "All mass," in Professor J. J. Thomson's opinion, "is mass of the ether, all momentum, momentum of the ether, and all kinetic energy, kinetic energy of the ether.* Only if this be so, he adds, "the density of the ether must be immensely greater than that of any known substance." The condition is startling, but in dealing with such subjects, we must not be too curious about anomalies. They come, as the ghosts appeared to Odysseus in Hades, at first one by one, then in an awe-inspiring swarm. Yet, in spite of the perplexities they occasion, we can discern with growing sureness of insight the amazing reality of the universal medium. It is, in a manner, the only reality. For what is manifest to sense is subject to change. We can conceive that the visible frame-work of material existence might crumble and dissolve, like "the baseless fabric of a vision," into seeming nothingness. But a substance that is inapprehensible is, to our limited ideas, imperishable. The ether is, indeed, the seat of intense activities, which lie at the root, most likely, of all the processes in Nature. An absolutely uniform medium, however, can scarcely be imagined to energise or react. Some kind of heterogeneity it must possess; and the heterogeneity, produced, in Dr. Larmor's view, by strains, is associated in Professor Reynolds's theory, with structure.

The "Sub-Mechanics of the Universe" are here made to depend upon the fitting together of ineffably small, ideally rigid grains. A misfit gives rise to matter, which might hence be defined as "ether out of gear"; and the misfit can be propagated endlessly from one range of granules to the next. This propagation through the ether of an abnormal arrangement of its constituent particles, without any transference of the particles themselves, explains the phenomena of matter in motion. A concrete existence belongs to the ether alone. It is composed of round, aboriginal atoms, the diameters of which measure the *seven hundred thousand millionth part* of the wave-length of violet light.† They are packed closely together, yet not so closely but that free paths are left to them averaging in length the *four hundred thousand millionth part* of their diameters. This inconceivably small relative motion suffices, nevertheless, to render the medium elastic; is, indeed, "the only cause of elasticity in the universe, and hence is the prime cause of the elasticity of matter." The medium so formed is ten thousand times denser than water; it exerts a mean pressure of 750,000 tons on the square inch; the coefficient of its transverse elasticity is 9×10^{21} (in C.G.S. units); which gives a velocity of transmission identical with that of light for vibrations of the same type, while longitudinal waves are propagated 2.4 times more rapidly. The scheme further includes a plausible rationale of gravity and of electrical effects; so that there is much to warrant the claim of its author to have excogitated "the one and only conceivable purely mechanical system capable of accounting for all the physical evidence, as we know it, in the universe."

The machine, to be sure, lacks motive power; but that is a want which no human ingenuity can supply. Its source is obscured in the primal mystery of creation. And, as regards the preliminary assumptions required for the constitution of an atomic ether, inclined though we might be to cavil at them, we should, perhaps, act more wisely in following Dr. Larmor's advice by abstaining from attempts to explain "the simple group of relations which have been found to define the activity of the ether. We should rather rest satisfied," he tells us, "with having attained to their exact dynamical correlation, just as geometry explores or correlates, without explaining, the descriptive and metric properties of space.'‡ Yet one cannot help remarking that the properties of space are not ordinarily modified to suit demonstration, while those of the ethereal medium are varied at the arbitrary discretion of rival cosmogonists. In the future, when they come to be more clearly ascertained, they will, perhaps, form the basis of a genuine new science. Already, the study of ethereal physics excites profound interest and attention. Nor is it possible to ignore the gathering indications that it will impose qualifications upon principles consecrated by authority and hitherto regarded as fundamental. The grand modern tenet of the conservation of energy, for example, may need a gloss; it may prove to be admissible only with certain restrictions. The second bulwark of the scientific edifice is even more seriously undermined. For the "strain-theory" of atomic constitution necessarily includes the conception of opposite distortions corresponding to positive and negative electricity. And the further inference lies close at hand that these, by combining, may neutralise one another. The coalescence, then, of a positive and negative electron should result in the smoothing out of the complementary strains they stand for; and there would ensue the annihilation of a pair of the supposed ultimates of matter. The event might be called the statical equivalent of the destruction of light through interference. That its possibility should be contemplated even by the most adventurous thinkers is a circumstance highly significant of the subversive tendencies inherent in recent research. Already, in May, 1902, Professor J. A. Fleming§ pointed out that "if the electron is a strain-centre in the ether, then corresponding to every negative electron there must be a positive one. In other words, electrons must exist in pairs of such kind that their simultaneous presence at one point would result in the annihilation of both of them." The consequence thus viewed in the abstract finds concrete realisation, if Mr. Jeans's suggestion be adopted,‖ in the processes of radio-activity, which may consist "in an increase of material energy at the expense of the destruction of a certain amount of matter." "There would, therefore, be conservation neither of mass nor of material energy."

No longer ago than at the opening of the present century, such notions would have been scouted as extravagant and paradoxical; now there is no escape from giving them grave and respectful consideration. Scientific reason has ceased to be outraged by hypotheses regarding the disappearance of mass and the

* *Electricity and Matter*, p. 51.

† *The Structure of the Universe*, Rede Lecture, June 10, 1902, p. 14

‡ *Nature*, June, Vol. LXII, p. 451

§ *Proceedings Royal Institution*, Vol. XVII, p. 177

‖ *Nature*, Vol. LXX, p. 101

development of energy. Mass and energy may, after all, be interchangeable; they are, at any rate, kept less rigidly apart in our meditations than used formerly to be the case. Nor can we assert with any confidence that partial subsidences into, or emergences from, the surrounding medium is for either a sheer impossibility; the universal framework, on the contrary, presents itself to us in the guise of an iridescent fountain leaping upward from, and falling back towards, the ethereal reservoir.

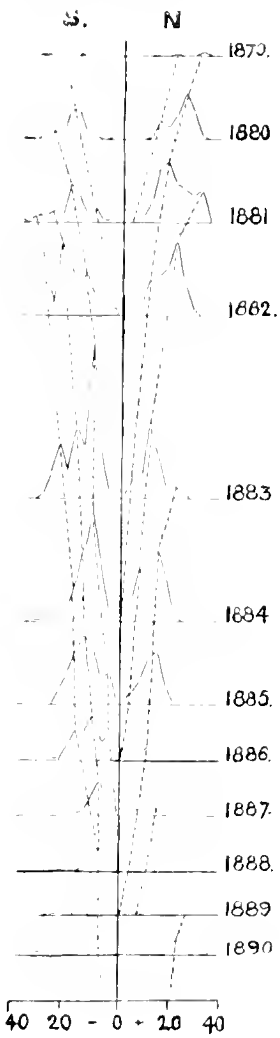
To the very brink of that mysterious ocean the science of the twentieth century has brought us; and it is with a thrill of wondering awe that we stand at its verge and survey its illimitable expanse. The glory of the heavens is transitory, but the impalpable, invisible ether inconceivably remains. Such as it is to-day, it already was when the *Fiat Lux* was spoken; its beginning must have been coeval with that of time. Nothing or everything according to the manner in which it is accounted of, it is evasive of common notice, while obtrusive to delicate scrutiny. Its negative qualities are numerous and baffling. It has no effect in impeding motion; it does not perceptibly arrest, absorb, or scatter light; it pervades, yet has (apparently) no share in the displacements of gross matter. Looking, however, below the surface of things, we find the semi-fabulous quintessence to be unobtrusively doing all the world's work. It embodies the energies of motion; is, perhaps, in a very real sense, the true *primum mobile*; the potencies of matter are rooted in it; the substance of matter is latent in it; universal intercourse is maintained by means of the ether; cosmic influences can be exerted only through its aid; unfelt, it is the source of solidity; unseen, it is the vehicle of light; itself non-phenomenal, it is the indispensable originator of phenomena. A contradiction in terms, it points the perennial moral that what eludes the senses is likely to be more permanently and intensely actual than what strikes them.

Pure science has usually, at all times and in all countries, been poorly paid, and we are reminded by an article by Father Tondorf in *Popular Astronomy* that the great Kepler had to supplement pure astronomy by doubtful astrology. Kepler did not believe in astrology. "Your error," he writes to a friend, "is one common to the greater part of the school of doctors, who fancy that fortunes drop from the skies. Naught comes thence save light"—but he had to supply horoscopes in order to supplement an insufficient income. Some of those who applied to him for predictions from the stars were half convinced with him that Astrology was the "foolish little daughter of Mother Astronomy," as witness the following letter to Kepler from Zeheutmeyer, secretary of Baron von Heberstein: "You are a man busied in scientific investigation and in reading the future in the stars. Please inform me whether these heavenly bodies indicate anything in particular regarding this section of the country. The Baron, my dear sir, is extremely anxious to give you, a man of such authority, a say in this matter. I am far from ignorant of your conviction that nothing can be foretold with certainty; in fact, that the science of astrology is a vague and treacherous art. However, you know how man hankers after news, and how he would have nature forewarn him of the future. I pray you, then, send me something. Harbour no fear. What you send shall be considered strictly confidential."

Sunspot Variation in Latitude.

By William J. S. Lockyer, M.A., Ph.D.

In the Astronomical Notes in this journal for July reference was made to a very brief discussion which took place at the Royal Astronomical Society on June 10 on the above subject. As this note seems to suggest that



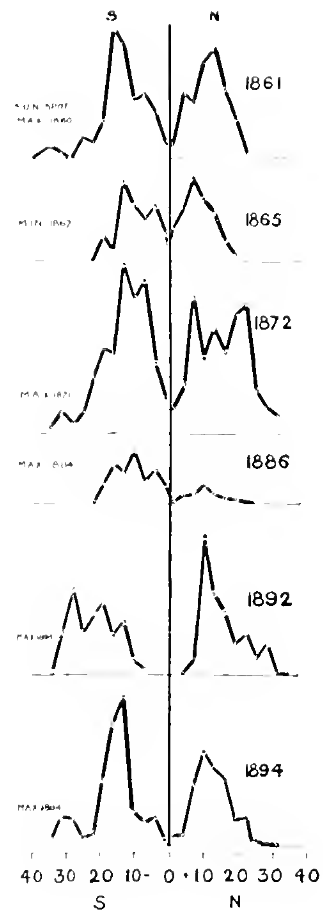


Fig. 1. The dotted lines indicate the loci of movement of the individual maxima of spotted area or the *spot-activity tracks*.

Fig. 2.—Some typical curves, showing the distribution of spotted area per 3° zones.

the results I have published (Roy. Soc. Proc. vol. 73, p. 142) are entirely in disagreement with those set forth by Father Cortie, perhaps I may be permitted to make the following remarks:—

Mention may first be made as to the meaning of the term "spot-activity track," which I think has been somewhat misunderstood by both Father Cortie and Mr. Maunder. The accompanying figure (Fig. 1), which includes a complete sunspot cycle, may, perhaps, help to make this term clearer. Each pair of curves above each horizontal line represents the variation in latitude of spotted area throughout a year as determined by summing up the spotted area for each

zone of 3° in width, using the values for each degree of latitude as published by Greenwich Observatory. A glance at those curves will show :—

(*a*) that many of them have more than one individual maximum;

(*b*) that these individual maxima do not always remain from year to year in the same position as regards latitude (though sometimes they do maintain the same for two, three, or four years together as can be gathered from the curves in my paper).

By joining up these maxima from year to year there appears to be a general drift from high to low latitudes; that is, the positions of the regions (zones) in which the spotted area is greatest change from year to year in a direction towards the equator. These lines of drift of the individual maxima, or their loci of movement towards the equator, are the *spot-activity* tracks. They are *not* tracks on the solar disc as seems to have been inferred.

An argument greatly in favour of this method of treating these multiple points of maxima individually is that we have a needed explanation of the anomalies, pointed out by Spoerer and Braun, of the mean latitude curves. The accompanying figure (Fig. 2) will give the reader some idea of the distribution of spotted area for several selected years, showing that although the spotted area extends over broad zones there are prominent subsidiary maxima included in those zones which should not be neglected. Against each of these pairs of curves the date of the nearest sunspot maximum or minimum has been inserted.

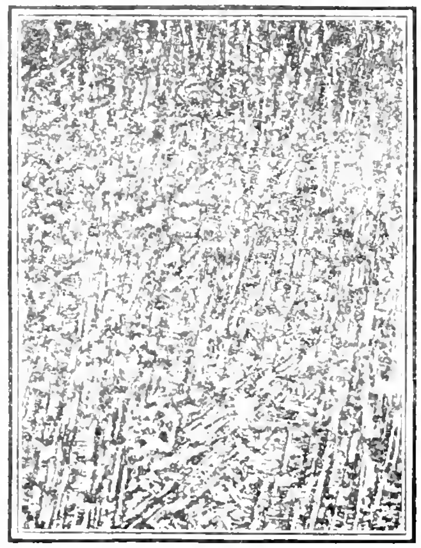
The writer of the note is quite in error when he says that Father Cortie showed "that the limiting latitudes for large sunspots rose from minimum to maximum instead of falling in the manner described by Dr. Lockyer." Father Cortie rather corroborated than opposed my result. As a matter of fact I pointed out, as one of the main results of my investigation, that outbursts of spots in high latitudes are not restricted simply to the epochs at or about a sunspot minimum, but occur even up to the time of sunspot maximum, and further, that there was a tendency after a sunspot minimum for each successive spot-activity track to make its appearance in latitudes higher than those just preceding it. This result I considered important since it was not in harmony with that which would be expected by Spoerer's Law, *i.e.*, that the highest spot latitudes occur about the time of sunspot minimum when a new cycle is in process of commencement.

"Notes on the Composition of Scientific Papers" (Macmillan and Co.), by Dr. T. Clifford Allbutt, Regius Professor of Physics at Cambridge, have been compiled in the hope of improving or forming the literary style of scientific students. In the course of the year Professor Allbutt tells us, in his humorous and engaging preface, he has to read some hundred theses for the degrees of M.B. and M.D.—"in composition a few are good, the greater number are written badly, some very ill indeed," so as "to obscure, to perplex, and even to hide or travesty the sense itself." It is difficult to say how far a sense of style can be imparted, but Professor Allbutt gives sound and excellent advice on the use of words and the construction of sentences, which might with advantage be taken to heart by others than scientific students.

"The Honey Bee" (Houlston and Sons), by T. W. Cowan, F.L.S., F.G.S., F.R.M.S., the well-known authority on bee-keeping, has reached a second edition. This comprehensive little volume, with its elaborate diagrams and illustrations, is valuable alike to the student and the bee-keeper.

The Birth of Crystals.

THE researches of Dr. Otto von Schron, Professor of Pathological Anatomy in the University of Naples, gave meaning some ten years ago to the expression "the living crystal." He showed that living matter, largely albuminous in character, takes the crystalline form, and, while still living and crystalline, obeys so many of the laws and manifests so many of the properties of inorganic crystallisation that its crystalline character may be said to be established. From these experiments he drew the inference that crystallisation in its terrestrial origin was a manifestation of life—of vital energy. In short, that a crystal grew for the same reasons that a plant grows, or the brain grows, or an amœba grows; that the vital forces stirring the one are no more than a different form of the forces that develop the other. The "living crystal," the "vital crystal" which, for example, he discovered as one of the products evolved by various of the bacilli that he



Alum in the Precrystalline state, showing appearance of lines of direction marking future axes. Enlargement, 280.

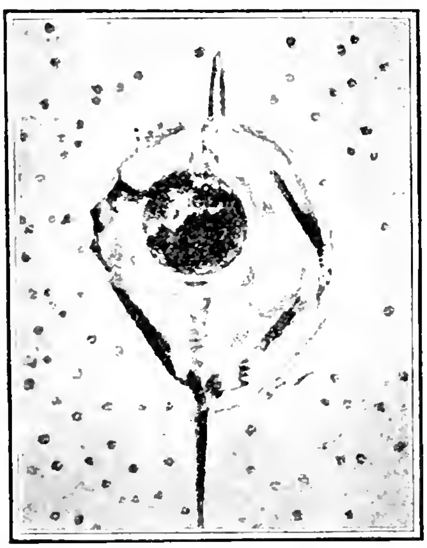
examined, became thus, in his theory, the bridge between what had heretofore been called living matter—animal and vegetable—and dead matter—mineral. The first crystals which set him on the road to this theory were the crystals of the Asiatic cholera bacillus, which he examined as long ago as 1886. They were long, needle-shaped prisms. Other bacilli examined exhibited distinct crystals of different forms. The *bacillus subtilis*, for instance, formed bayonet rhombs; the *bacillus tenuæformis* hexagonal prisms; the tubercle bacillus develops square rhombs; anthrax, elongated rhombs; any given bacillus being immediately identified by its crystal, which never varies in the shape assumed in its original formation. These objects are perfect crystals in form; yet, as anyone may see, they are alive, and their life, their motion, and their reproduction are as visible and undoubted as their death when it ensues is undoubted. Their death occurs when all the living matter which originally formed part of the crystal has eliminated itself. On death they become the crystals that we know, ordinary mineral crystals.

Such were the beliefs and theories, rather freely stated, of Von Schron; and their interest at the present time lies in the re-statement by MM. F. di Brazza

and P. Pirenne in the *Revue Scientifique*, of the hypothesis that crystals have a kind of life, of a lower grade than that of plants, but still real life. These writers found their theories on phenomena observed under a microscope during the growth of a crystal from a solution. These phenomena have several features in common with the growth of a living cell.

Salicylic Acid in Precrystalline state, showing birth of multipolar cellules resembling nerve cells. Enlargement, 280.

If we dissolve salt in water until the liquid is saturated and then modify the conditions by lowering the temperature, we see crystals of the dissolved salt appear. The process apparently simple, and dependent on easily-stated chemical and physical laws, appears none the less to originate in a series of

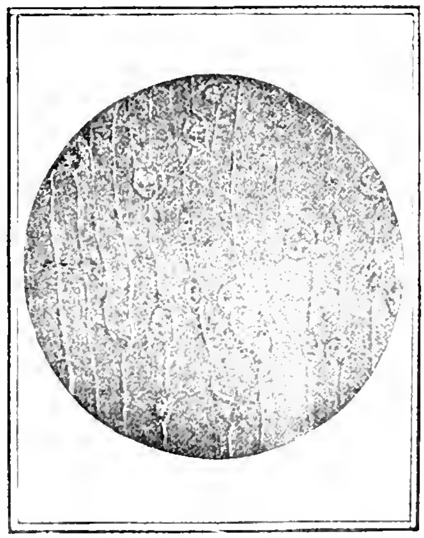


Large Petro-cellule of Quartz, showing two protoplasmic substances, and nuclear petroblast. Enlargement, 750.

phenomena that have a remarkable similarity to vital phenomena. According to MM. di Brazza and Pirenne: "At the beginning of the crystallisation a tiny globule is seen to be differentiated from the uniform mass, being easily recognisable on account of its difference in refractive power. Studied closely, this globule shows within it a slight 'petroplasmic network,' which shows an analogy with the formation of animal and vegetable cells. . . . . .

"Then are seen appearing in the network small obscure points called 'petroblasts,' which, when observed under high magnifying power, seem to be at the centre of a dark substance called 'deuterolithoplasm,' and on the periphery of another clearer substance named by Von Schron 'protolithoplasm.' The formation of the crystal results from these two substances. . . . Crystals have different origins, but . . . the petroplasmic kind is by far the most common. In the strife between the two substances constituting the petroblast, the globule changes form by an annular enlargement; the ring then is deformed and an angle is formed which Professor von Schron calls the 'primitive dominant angle,' because it gives the direction of the future crystal. Soon a second angle forms opposite the first, called the 'diagonal angle.' Finally the meeting-points of these two opposed angles form new angles called 'secondary.' . . . . . .

"The crystal, whose formative phases we have thus studied, can move about, and also presents the



Salicylic Acid in Precrystalline state, showing numerous petroblasts with nuclei. Enlargement, 610.

peculiarity of being able to reproduce itself in three ways—by division, gemmation, and endogeny.

"1. By division. If we take, in special conditions, a crystal of recent formation, we shall see it separate into two individuals which draw apart with a rotatory movement.

"2. By gemmation. The phenomenon takes place in the following manner: the petroblasts develop, reach the surface of the crystal, continue to develop, and are detached, causing waves around the crystal.

"3. By endogeny, the most original case. A little crystal forms inside the mother crystal, comes to the surface and issues from it with a double movement of progression and rotation.

"Life in crystals can be explained by the struggle for existence, which is ardent even here. In fact, if during their growth two crystals come into contact, the weaker will completely disappear, absorbed by the stronger. . . . The crystal seems actually to be a living being, and, as we have said, it should have its special pathology. This is really the case, according to Von Schron, who has discovered fifteen kinds of disease in crystals, some of which are hereditary—cases of bifurcation, torsion, and erosion, which are confirma-

tory of the new theory. When its vital cycle has been complete, the crystal then becomes old and is fossilised. It is then inert."

What is the origin of the little globules whence, as has been stated above, all crystals arise? Have they germs or seeds of some kind? Von Schron thinks not. He regards the inception of the crystal as real spontaneous generation. M. di Brazza, however, criticises this attitude. He asks:

"Why can we not ascribe to the molecule, this infinitely small constituent part of things, the primary generative faculties and substitute for the formulæ of Redi and Virchow* a new one: *Omne vivum ex molecula* [all life from the molecule]?"

This hypothesis the writers submitted to Von Schron, who reaffirms his belief that the crystal has absolutely no pre-existing nucleus, molecular or other, in the solution in which it arises.†

* *Omnis cellula e cellulâ.*

† Professor Von Schron remarked in his earlier papers that in the preparation and development of bacilli four products were evolved. They were i., a colourless liquid which forms the envelope about the spore-forming bacillus; ii., gas; iii., irregular masses of albumen; iv., crystals.

Obituary.

DR. ISAAC ROBERTS, F.R.S.

It is with exceeding regret that we have to record the sudden death on Sunday, July 17, of Isaac Roberts, D.Sc. (Dublin), F.R.S., F.R.A.S. There is no need to tell the readers of "KNOWLEDGE" of the contributions which Dr. Roberts made to the science of astronomy by his photographs of stars, clusters, nebulæ, and comets. Many of these he published in its pages, and his last contribution—three beautiful presentations of Comet Borelly (c 1903)—in the October number of last year, must be fresh in the minds of all. Since 1890 he devoted himself almost entirely to astronomy at his residence, Starfield, Crowborough, where he built an observatory, equipped with a 20-inch reflector and a 5-inch Cooke refractor. In earlier years he had also made a study of geology, and was elected a Fellow of the Geological Society in 1870. In 1882 he was elected a Fellow of the Royal Astronomical Society; he served on its Council for some years, and was awarded its gold medal in 1895 for his astronomical researches. In 1890 he was elected a Fellow of the Royal Society, and in 1892 the University of Dublin conferred on him the hon. degree of Doctor of Science. In October, 1901, he married Mdlle. Dorothea Klumpke, D.-es-Sc., who had previously been head of the Bureau for measuring the plates of the International Catalogue in the National Observatory at Paris. In 1893 and 1899 he published two volumes of photographs of star-clusters and nebulæ, photographs which, if his work is continued, will afford ere long evidence of the nature of the changes which are going on in the stellar universe. Dr. Roberts was born in 1829.

CAPTAIN WILLIAM NOBLE, F.R.A.S.

ENGLISH astronomy has suffered a very grievous loss in the death of Captain William Noble, of Forest Lodge, Maresfield, Uckfield, Surrey. He was born in 1828, and for some years was a member of the Rifle Brigade, and after his retirement from the service he took an active interest in the politics and business of his county, being a Justice of the Peace for many years before his death. He took a great interest in many scientific subjects, but his chief pursuit was astronomy, and he was elected a Fellow of the Royal Astronomical Society on June 8, 1855, and served on its Council with but short intermissions from 1867 until 1902. He was an original member of the British Astronomical Association, was its first President, serving from 1890 to 1892, and contributed largely to its success. He communicated many papers to the "Monthly Notices" of the Royal Astronomical Society, to the "Journal" of the British Astronomical Association, to the "Observatory," to "KNOWLEDGE," and to the "English Mechanic." To the last periodical he contributed for many years a fortnightly letter, under the signature of a "Fellow of the Royal Astronomical Society." He had also the author of "Half-Hours with a 3-inch Telescope," a book of great practical value and aid to amateurs beginning a study of the Moon and planets. He was himself a good observer, and his drawings of Jupiter and Mars and of portions of the Moon are both truthful and accurate. He was a most engaging personality. It was not only that he took an interest in astronomy and the work of astronomers, but he manifested his interest in a breezy and genial fashion. He had always ready to help by word or letters the novice in the science that he himself loved. His death took place on Saturday, July 9, 1904.

PROFESSOR THEODOR BREDICHIN.

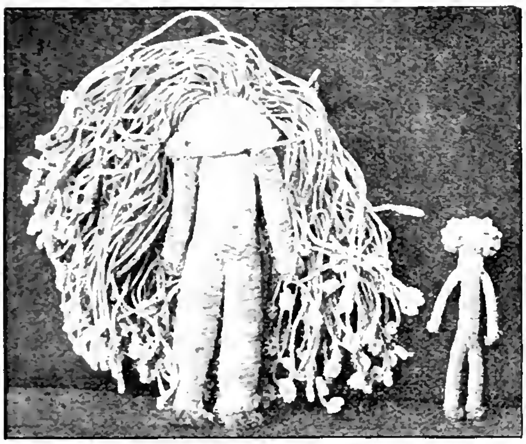
PROFESSOR THEODOR BREDICHIN died on May 14, 1904, after a short illness. Russia has lost in him her most eminent astronomer and the one who has had most influence on the development of astronomy, both as Professor and as Director, successively, of the two largest Russian observatories—Moscow and Pulkowo. He was born on December 8, 1830, in Nicolaieff, and was educated first at the Richelieu Lyceum in Odessa, and then in the University of Moscow. He was elected Professor of Astronomy at the University in 1857, and in 1873 was made Director of its observatory. Here he initiated observations of stellar spectra, of the places of stars, and the determination of gravity through observations of pendulums. But his great work was his research on the forms of comets with which was connected his theory of meteors. In 1890 he succeeded O. Struve as Director of the great Pulkowo Observatory, and here he remained until 1894, when he resigned his Directorate and retired to Petersburg to pursue his cometary investigations. He was elected a foreign Associate of the Royal Astronomical Society in 1884.

AT the Royal Society's conversazione was exhibited a little instrument devised by the Hon. R. J. Strutt and called a radium electroscope, in which the departure of negative ions from a speck of radium enclosed in a sealed vacuum tube perpetually charges the leaves of an electroscope also inside the sealed tube. The action is probably not perpetual, but so long as the radium lasts, say 30,000 years, the tiny leaves of the electroscope will go on opening and shutting so many times a minute, like a clock or a perpetual motor. But this spectacular form of motion is not the limit of the radium electroscope's potential activities. Mr. Harrison Glew has devised an arrangement by which the periodical discharges of the electroscope, when the leaves touch the side of the sealed glass tube (in which a wire connects two inner coatings of zinc foil to earth), rings a bell or prints a record of every contact of the leaves. Each discharge from the outside terminal of zinc foil and wire, when the leaf strikes the inner foil, is sufficient to act on a "coherer" similar to that which is used in wireless telegraphy. The "coherer," as in a wireless telegraphic system, is put in a bell circuit, and each time it is acted on, as it might be acted on by a train of Hertzian waves, it rings a bell. In Mr. Glew's experiments, with a three milligrammes speck of radium, the bell was rung every seventy seconds. Thus we might devise a perpetual "minute bell."

The Dolls of the Tombs

The Beni Hasan Excavations.

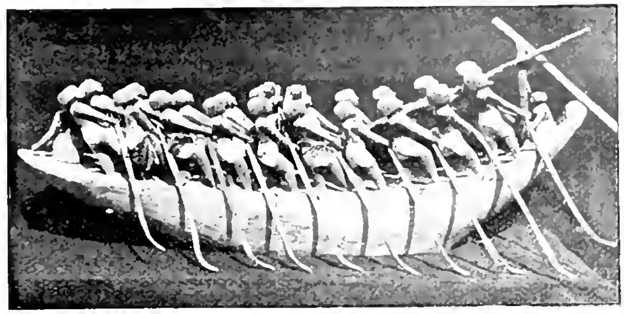
By the kindness of Mr. John Garstang, director of the Beni Hasan Excavations, we are able to reproduce some photographs of the extraordinarily interesting models and the fascinating dolls which have been found by him in the excavated tombs of Beni Hasan. Our thanks are also due to the Council of the Anthropological Institute, in whose journal, *Man*, May, 1903 and July, 1904, the photographs have already appeared. These models, placed in their rocky tombs 4,000 years ago, were recently exhibited at the Society of Antiquaries' Rooms, Burlington House, and proved without doubt the most attractive archaeological exhibition of the year. Some of the models have been shown in London before, and Princess Henry of Battenberg was an interested visitor, not at Burlington House alone, but at the excavations themselves in Egypt. The attraction of the dolls is of a double kind. It lies not only in the knowledge that they are the handiwork of 4,000 years



String Dolls. Tomb 420.

ago, or that they represent the life of those times as well as the probable superstition that the presence of such dolls in tombs ensured for the human body buried there the company, assistance, and service of slaves, soldiers, and equipment in the Paradise where the soul had gone; but it is to be found also in the extraordinary vividness of the dolls themselves. They are sometimes rudely carved, but they are always lifelike. There are dolls in granaries and dolls in war-galleys—wonderful dolls these, with a world of expression in their glaring eyes, though the eyes are only two dashes and a dot—and a wonderful vigour in the way their wooden arms strain at the sweeps. You can almost hear the yell of the steersman and the crack of his whip. Then there are dolls baking, kneading, butchering; and a wooden bullock with meek legs bound together is ready decorated for the sacrifice. The wooden priests stand near with wooden gestures of uplifted piety. In one galley the dolls are playing chess! Then there are dolls of historic interest; the dolls that point to a Libyan irruption and a renaissance of new ideals in the art of dolls; and a beautiful wooden portrait doll, with an archaic smile on his well-cut lips and determination writ plainly on his jaws and fist. Lastly, there are the real dolls of that forgotten day, dolls that were made of string and had curly locks of threaded beads—such were the dolls that little Neith-Hetep or Ayesha played with 4,000 years ago.

Of the excavations, Mr. Garstang writes:—"It was early in December, 1902, that excavations commenced in the vicinity of Beni Hasan. The site is on the east bank of the Nile, where the river approaches somewhat closely to the limestone cliffs that bound the valley, some fourteen miles southward from Minia, a great



Rowing Boat of Twenty Oars. Tomb 116.

town of Middle Egypt. The site has long been famous for its long gallery of Middle Empire tombs, which are hewn in the living rock, well up the slope. These are decorated in their interior with scenes, painted with realism upon the dressed surface of the walls, which are the more interesting in that they represent, in many cases, incidents of daily life in the home and in the fields, as well as the rites pertaining to the dead, in the age to which they belong, more than 2,000 years B.C. Historically they belong to the feudal period of Egypt, when the Government was in the hands of powerful chieftains—hereditary owners of the soil, and they bridge over the intervening years during which the monarchy slowly regained its authority, and was finally re-established by Amenemhat III.

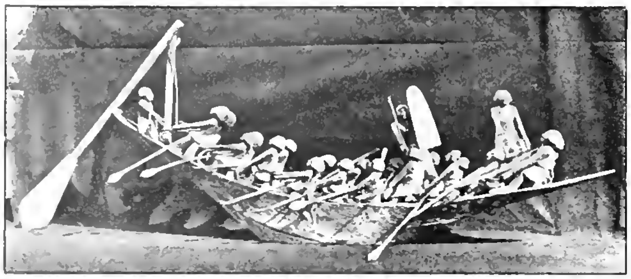
These great rock-hewn chambers, for the most part, indicate the burial places of these feudal lords, whose great sarcophagi were placed in small recesses at the foot of deep square shafts within them. It might have been suspected that the court officials of these great chieftains, who kept up regal pomp, would seek burial in the same vicinity; and that the tomb furniture and burial deposits placed with them might illustrate more fully the civilisation and culture of the age: such was,

The Making of Beer. Tomb 116.

indeed, the quest of this expedition. The necropolis was discovered ranging along the face of the cliff, just below the famous gallery; and 887 tombs were found and excavated during the two years' work. The presence of these was already indicated, indeed, by the numerous open mouths of shafts sunk in the limestone.

The first tomb discovered and entered gave an indica-

tion. The shaft had been found filled by design with large masses of rock and the door of the chamber was closed with rough-dressed stones built up like a door. On removing these the interior showed the tomb of a courtier named Antef, undisturbed and preserved in its entirety as it had been left by the ancient Egyptians at his funeral, 4,000 years before. The wooden sarcophagus, with its lines of religious formulæ and text painted in hieroglyphic character upon it, lay within, head to the north, and the painted "eyes of Osiris" towards the east. Upon it, and by its side,



Boat with Armed Man.

were little wooden models of river and sailing boats, a granary, a group of persons baking, a man brewing, another leading an ox, a girl carrying a brace of birds in her hand and a basket on her head. The oarsmen still clinging to their oars, through all the lapse of years, and the paint was fresh upon the wooden figures. It was a wonderful sight; one which rewards a lifetime. Within the sarcophagus were the bones of Antef, wrapped around with a linen cloth, which was still preserved, while the body had decayed. His pillow, a wooden one, was by his head, and a pair of sandals at his feet.

This first tomb entered proved characteristic of the whole number, and the result is a wealth of information as to the life and ritual of the Egypt of that distant day.

NOTES

ASTRONOMICAL.

A Possible Variation of the Solar Radiation.

The *Astrophysical Journal* for June opens with a paper by Professor S. P. Langley, in which he shows cause for concluding that there was probably a fall in the solar radiation at the end of March, 1903. The determination of any such variation in the solar constant is one of extreme difficulty owing to the great and varying effects of the absorption exercised by our atmosphere, and Professor Langley puts his results forward with all due caution. But the introduction of automatic methods for registering the observations of the bolometer, and improvements in the instrument itself, so that the zero of the galvanometer remains almost unchanged for weeks together, justify the attempt to asertain if any such variation can be detected. The chief difficulty lies in the calculation of the total absorption exercised by our atmosphere so that the radiation recorded at the observing station may be corrected so as to exhibit the radiation as it would be recorded were the atmosphere removed. The only method at present available is by the comparison of observations made with the sun at different altitudes, and acting through different thicknesses of air. The measurement and reduction of a series of from five to ten bolographs of a single day involves so much labour that a single computation of the solar constant takes about a week. The effects due to the atmospheric absorption having been allowed for, a series of observations made at the Smithsonian Astrophysical Observatory, from October, 1902, to March, 1904, appears to show that the solar radiation itself fell off by about 10 per cent., the change beginning late in March, 1903. Such a change should be followed by a decrease of temperature on the earth less than 7·5 C., and on comparing the observed temperatures at 89 stations in the North Temperate Zone, an average decrease of temperature of over 2° C. was actually found to be shown; stations far from the retarding influence of the oceans showing the greatest variation. The mean temperature curve of the 89 stations shows a striking correspondence with the curve of the solar constant during the first 8 months of 1903, but rises in the last 4 months. This rise may be due to an increase in the transparency of the earth's atmosphere, the Smithsonian observations indicating that there was a great falling off in such transparency from February to August, 1903, but a recovery later, though the maximum value recorded in 1901-2 was not fully attained.

* * *

The Electric Equilibrium of the Sun.

An important paper by Professor Svante Arrhenius was communicated to the Royal Society on June 2 by Sir William Huggins. Professor Arrhenius had previously pointed out that several electric and magnetic phenomena might be connected with the pressure of radiation. The gases in the solar atmosphere are practically ionised by the ultra-violet radiation; the negative ions condensing vapours more easily than positive ions. A large majority of the droplets formed by condensation in the sun's atmosphere are thus negatively charged and driven away, charging with negative electricity the atmospheres of celestial bodies, *e.g.*, the earth, which they meet. Calculating the speed with which these particles will move through space, Arrhenius finds that on the average they would reach the earth in about 46 hours. Now Ellis and Maunder have shown that the magnetic storms commence 26 hours in the mean after the sun spots which probably cause them reach the central meridian of the sun. Riccò found that the height of the storm is attained on the average about 45·5 hours after the transit of the spot; a result practically coinciding with that of Ellis and Maunder, and with the speed deduced by Arrhenius for these negatively electrified particles.

But a difficulty arises here, for the emission of these particles from the sun should result in its soon assuming so great an electric charge of positive sign as to hold back the negative particles. But if these drops should agglomerate the potential increases, and larger masses are formed which can part slowly with their negative charge in the form of electrons traversing space with a velocity much less than that of light. Such electrons would, in general, not pass by many suns without being caught by them. In this way, Professor Arrhenius suggests that the supply of negative electricity to the suns is proportional to their deficiency in it. This balance supposes that the chief forces driving the particles away from the sun are, like the pressure of radiation, not electric; but for the negative electrons caught by the sun, forces other than electric are relatively insignificant.

* * *

Mr. Yendell's Observations of the Colour of Certain Variable Stars.

In the *Astronomical Journal* for June 20, 1904, Mr. Paul S. Yendell gives an extension of Professor Chandler's examination of the colours of the variable stars (*A. J.*, VIII., 137) to the more recently discovered variables. The observations were made with a screen of a full blue colour, formed into a double eye-glass, so that it could be used either with the naked eye or with the binocular, and an examination of the spectrum of the light transmitted by this glass showed a large absorption throughout the whole of the red and yellow. The observations were carried on more or less continuously from 1893

until 1901, and the cases of 53 stars are discussed. These 53 stars are divided into three classes according to their types of variation. There are eight short-period stars of the η Aquilæ and β Lyræ types; seven of types which may be called intermediate with periods of from 40 to 105 days; and 38 stars which are distinctly of the long-period type. In the first class, where the stars have a short-period variability, there does not seem to be any suggestion of a relation between colour and length of period. In the second class, or "intermediate" stars, there is evident a marked progression in the lengths of their periods, corresponding to that in their observed colours. In the third class, consisting of 38 long-period stars, the correspondence between depth of colour and length of period is so marked as to point strongly to some real connection between the two, confirming Chandler's dictum that "The redder the tint, the longer the period." The variation also seems to become increasingly irregular.

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The Spectroscopic Binary, β Aurigae.

Not quite a year ago, Mr. G. A. Tikhoff, from a discussion of spectrograms of β Aurigæ taken at the Pulkowa Observatory, concluded that the star is not merely double but quadruple, being composed of two groups of bodies, each of which consists of a star with strong lines and a second star with weak lines. The revolution of the two groups takes place in slightly less than four days, but of the stars in each group in one-fifth of this time. This inference was based on the complex appearance occasionally presented by the $H\gamma$ line; and caused Professor Vogel to set on foot a new series of observations of the star. These have not led him to support Mr. Tikhoff's views. By a very slight alteration of the adopted period he was able to bring the 55 observations at his disposal very satisfactorily on a single curve; and he concludes that there is no sufficient reason to accept the quadruple structure of the system. With a circular orbit and a period of 3·9599 days, and a relative velocity of 222km., the mass of the system comes out as $4{\cdot}5 \sin^{-3} i$ that of the sun, and the distance of the two bodies apart as $a \sin i = 12{,}000{,}000$ km. The radial velocity of the system is found by Vogel to be -21 ± 1 km. agreeing well with those found by Deslandres and Tikhoff.

* * *

The Visibility of Lines and Wires.

Mr. Lowell is following up his earlier experiments as to the extreme limits of visibility of lines and wires, and in Bulletin 10 of the Flagstaff Observatory, he gives the results obtained by two of his assistants. These found it possible to glimpse or suspect a line or wire when its angular width was only 0″·8 of arc. No marked difference was found between the limit for a blue line ruled on white paper, and that for a wire seen against the sky.

* * *

Radial Velocities of the Pleiades.

The Pleiades in general do not give spectra favourable for determinations of radial velocities; they lack the metallic lines seen in Sirian and solar stars, and the lines of helium are usually weak and diffuse. Mr. Walter S. Adams has been able to deal with six stars of the group with some success; the speeds deduced in kilometres per second being as follows:—Merope + 6, Atlas + 13, Electra + 14, Alcyone + 15, Taygeta + 3, whilst Maia was found to vary in velocity. Merope was observed with most difficulty, Maia with least; the first four stars showing spectra like those of nebulous stars, whilst Taygeta and Maia should possibly be regarded as not physically connected with the nebulosity.

* * *

An Expedition for Solar Research.

Professor G. E. Hale is conducting an expedition to Mount Wilson (5886 feet), near Pasadena, California, for the purpose of making special investigations of the Sun. The chief instrument will be the Snow horizontal telescope recently constructed at the Yerkes Observatory. This consists of a 30-inch cœlostat, with a 24-inch subsidiary mirror by which the light can be deflected on one of two concave mirrors also of 24 inches diameter. One of these has a focal length of 60 feet, the other of 145 feet. The latter giving a 16-inch solar image will be used in conjunction with a spectroheliograph of 7 inches aperture and 30 feet focal length. Three focal slits will be used together, so that three different parts of the spectrum may be photographed simultaneously. The 60 foot mirror is to be also used in connection with a spectroheliograph, but a special attempt will be made to photograph with it some of the brighter stars, using a stellar spectrograph provided with a large concave grating and mounted in a constant temperature laboratory.

* * *

Eclipse Problems.

In the *Popular Science Monthly* for June, 1904, Professor W. W. Campbell discusses the more important points of eclipse problems. He first considers the question of intramercurial planets. The experience of 1901 was almost but not quite conclusive against their existence; if similar successful photographs were taken in Labrador, Spain, Tunis, and Egypt in 1905 the question would be settled one way or other. The reversing layer comes next. Additional work with more powerful instruments in perfect adjustment is required; and especially photographs taken on continuously moving plates are needed, since exposures of two or four seconds integrate the changes which are going on. The chief problem is the corona, since we do not yet know whether the material of the streamers is moving outward, inward, or in both directions, or in neither. It is essential that identical instruments of long focus be employed in at least three widely separated stations to photograph the corona with a common scheme of exposures. Professor Campbell regards this question of coronal movement as the most important of the coming eclipse. Other problems are the sources of light and heat for the outer corona, calling for thermographic and polarigraphic observations; the bright line spectrum of the inner corona in 1905, at sun-spot maximum, comparing the thickness and uniformity of this stratum with the results obtained at the recent eclipses at minimum; the accurate determination of the wave length of the truly coronal lines so that a serious effort may be made to represent them by a simple common law, as with hydrogen and helium. Professor Campbell concludes with insisting on the need for insuring against personal failures by at once making the fullest possible preparation. Failures in the past have been largely due either to attempting too large a programme for the time of totality, or more usually to want of adequate experience of the instruments or methods employed.

ORNITHOLOGICAL.

By W. P. Pycraft, A.L.S., F.Z.S., M.B.O.U., &c.

Killdeer Plover in Aberdeenshire.

Readers of this column will probably be interested in the fact that I have just discovered an undoubtedly British-killed example of the Killdeer Plover (*Ægialitis vocifera*) in the University Museum of Aberdeen, though for thirty-seven years it has passed for the common ringed Plover (*Æ. hiaticula*). The label on this specimen runs as follows: "*Charadrius hiaticula*, Ringed Dotterel, shot at Peterhead by Andrew Murray, jun., Esq., 1867."

From this label, which is yellow with age, there can be no doubt but that this bird was presented by the donor simply as a common ringed dotterel. To allay all doubt, Professor J. Arthur Thomson, in whose care this bird now rests, has kindly interviewed Mr. Murray for me, and he distinctly recollects the circumstance in connection with this incident.

The Killdeer Plover is admitted into the British list by Mr. Howard Saunders on a single example shot at Tresco, Scilly Islands, and described in the *Zoologist* for 1885, p. 112.

* * *

Yellow-legged Herring Gull at Dover.

At the last meeting of the Ornithologists' Club, held June 15, the Hon. N. Charles Rothschild recorded that he had observed in Dover Harbour, on April 18 last, a bird which he considered to have been an example of the Yellow-legged Herring Gull (*Larus cachinnans*). The bird in question was flying in company with

several of the common Herring Gull (*L. argentatus*), and passed unusually close.

The bird was noticed to have orange legs, not only by his brother, the Hon. Walter Rothschild, but also by the Hon. F. R. Henley.

* * *

Longevity of Eagle Owl.

Mr. E. G. B. Meade-Waldo has just forwarded to the Natural History Museum a female Eagle Owl (*Bubo ignavus*), which had lived seventy-two years in confinement, having been brought from Norway in 1820; and during the last fifty years had reared no less than ninety young.

The mate of this bird is now fifty years old, and still vigorous.

Although the Eagle Owl is reputed to live to a great age, there are surprisingly few similar instances recorded where the age has been definitely ascertained. A golden eagle which died at Vienna in 1719 was known to have been captured 104 years previously; and a falcon, of what species is not recorded, is said to have attained an age of 162 years. A white-headed vulture taken in 1705 died in the Zoological Gardens at Vienna in 1824, thus living 118 years in captivity.

* * *

Herring Gull Laying in Confinement.

I have recently obtained circumstantial evidence of the fact that a Herring Gull (*Larus Argentatus*) has, after twenty-two years in captivity, commenced egg-laying. Two eggs were laid by this bird during the present spring, at intervals of a week. Both were quite normal in size and colour, and, after laying the second egg, the bird commenced to sit, but the eggs, of course, were infertile. Wild Herring Gulls frequently approached her, but of these, strangely enough, she took no heed.

* * *

Breeding of Crested Screamer in Confinement.

A pair of Crested Screamers (*Chauna chavaria*) have just successfully hatched out three nestlings in the Gardens of the Zoological Society. Careful observations kept during the period of incubation show that the male takes a full share of the brooding, which lasts three weeks. The young are said to resemble goslings, but not very closely. They are yellow in colour, and have *no* stripes. They are described in the *Field* for July 9 as having no down, but being clothed in feathers which are miniature copies of those of the Rhea. This description is somewhat remarkable, and demands further consideration.

* * *

Allen's Gallinule at Sea.

An example of Allen's Gallinule (*Porphyriola Alleni*) has just been sent to the London Zoological Gardens. It was taken at sea, 140 miles from the nearest land—the west coast of Africa. A similar instance occurred in 1870, when a specimen was taken on board a ship off the coast of Sierra Leone.

ZOOLOGICAL.

Armadillos in North America.

WITH the exception of one or two species, ranging into Texas and the adjacent States, armadillos, both recent and fossil, have hitherto been supposed to be confined to South and Central America, inclusive of Mexico. The discovery is, however, announced of the skeletons of extinct members of the group in the Lower Tertiary, or Eocene, formations of the United States. In place of the bony armour characteristic of the existing and later Tertiary members of the group, these primitive armadillos appear to have had their backs protected merely by a shield of hard leathery skin. The discovery must profoundly modify current views as to the origin of the South American fauna, indicating apparently that armadillos, at any rate, were immigrants into the southern half of the New World from the North.

An Insect Pest.

One of the most terrible of insect pests appears to be the minute black fly of the Mississippi Valley, commonly known as the buffalo gnat, from a fancied resemblance in outline to the buffalo, or bison. The buffalo-gnat chiefly attacks the larger kinds of live stock, although it will occasionally bite, and even kill, human beings. In the year 1874 it is stated that in a single county in Tennessee these insects killed stock to the value of £100,000; while within a single week one parish in Louisiana lost 3,200 head of live stock. Horses and mules, during such visitations, are killed while working, or before they can be got under cover when grazing; while in some of the cities on the Mississippi the running of tramcars has been rendered impossible.

* * *

Gulls and Fish.

Confirmation of the view expressed in our last issue as to the serious extent of the damage caused to our sea-fisheries by gulls is afforded by a note in the *Field* of July 11, from Mr. J. A. Harvie-Brown, a well-known field naturalist. According to this gentleman, there can be no doubt that certain species of gulls, if not indeed all, are far too numerous, not only on account of the fish they destroy, but also owing to the destruction they inflict on the eggs and young of other birds. Mr. Harvie-Brown goes, however, further than this, and considers that much of the bird protection in this country is downright harmful.

* * *

A Rare Rodent.

Everything comes to him who waits. As noticed in our summary of papers read, Dr. E. A. Goeldi has recently communicated to the Zoological Society a notice of certain rodents living in the Museum at Pará, Brazil. The species to which these rodents belong (*Dinomys branickii*) has been hitherto known only by a single specimen which was found early one morning about the year 1873 wandering in the courtyard of a house in Lima, Peru. Although it was considered by its describer to indicate a family and genus whose nearest relative is the Paca (*Cœlogenys paca*), the suggestion has been made that it was a hybrid between that animal and some other large rodent. The specimens now living at Pará suffice to dispel this theory; and when Dr. Goeldi's description is published we shall be able to appreciate the true affinities of this remarkable and interesting creature.

* * *

The Orkney Vole.

Unusual interest attaches to the discovery by Mr. J. G. Millais in the Orkneys of an entirely new species of short-tailed field-mouse, or vole, which is described in the *Zoologist* for July under the name of *Microtus orcadensis*. Having no affinity with the red-backed, or bank, vole (*Evotomys glareolus*), the Orkney species comes nearer to the common field-vole (*Microtus agrestis*), from which it differs not only in proportions and colour, but likewise in the structure of its cheek-teeth. It is, therefore, nothing in the way of a sub-species, but a perfectly distinct species, which does not appear to present a near relationship with any other known member of the group. That such a totally distinct type should turn up in the Orkneys is certainly most surprising, and it suggests a number of problems in the geographical distribution of animals. Mr. Millais is to be heartily congratulated on having been the means of making known such an important and interesting addition to the British mammalian fauna.

* * *

Papers Read.

At the final meeting for the session 1903-4 of the Zoologica Society of London a large number of exhibits were made and papers taken. Among the exhibits, reference may be made to a series of hybrid pheasants killed in the coverts at Woburn Abbey belonging to the Duke of Bedford; and likewise to a skull of the Cape crowned crane, showing bony processes suggestive of the horns of mammals. Living specimens of hairless rats and mice were also shown. The papers included one by Colonel J. M. Fawcett on certain butterflies from the North-West Himalaya and elsewhere, and a second, by Mr. A. G. Butler, on seasonal changes in butterflies. Captain R. Crawshay contributed notes on the prey of the lion, directing

special attention to a number of porcupine quills found buried in the fore paws of one of these animals. Mr. F. E. Beddard read papers on certain features in the anatomy of three groups of reptiles, namely skinks, sea-snakes, and the Australian skinks of the genus *Egernia*. Next came the communication by Dr. Goeldi on the South American rodent *Dinomys branicki* to which special reference is made in an earlier paragraph of these "Notes." Dr. C. Satunin described the black wild cat of Transcaucasia as a distinct species; while Mr. Lydekker contributed notes on a new race of buffalo from East Central Africa, and on a new species of tufted deer (*Elaphodus ichangensis*) from Ichang, Central China. Finally, Dr. A. S. Woodward read a paper on two skulls of primeval salamanders, or labyrinthodonts, from strata of Triassic age, the one from Staffordshire and the other from Spitzbergen. At the last meeting for the session of the Geological Society of London, Mr. W. F. Gwinnell described the vertebral column of a small plesiosaur from the Rhætic strata of Westbury-on-Severn, Shropshire. Hitherto the plesiosaurian vertebræ obtained from this horizon have consisted only of isolated vertebræ. At the final meeting for the session of the Linnean Society held on June 16, Dr. W. Kidd read a paper on variations in the arrangement of the hair on the neck of the horse, in which it was sought to test the validity of the theory that certain peculiarities in hair arrangement among them are generally due to mechanical causes. Mr. J. Cash contributed a paper on British freshwater rhizopods.

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The Poison of Vipers.

For some time it has been known that the serum prepared from cobra-poison and known as Calmette's antivenin is to a great extent effectual against the results of the bite of the snake itself. Experiments have recently been undertaken by Dr. Rogers, of the Indian Medical Service, with a view of ascertaining whether a similar serum has equally good effects against the results of the venom of the Indian sea-snakes and other members of the colubrine group whose bite is poisonous. The results of these experiments have been published in a recent issue of the "Philosophical Transactions," and serve to show that the poison of all these snakes has the same effect, namely, paralysis of the lungs. Accordingly, there is every probability that such poisonings may be neutralised by a serum like Calmette's antivenin, although this must be of much greater strength in order to be effective. On the other hand, it has been found by Dr. Rogers that the poison of snakes of the viperine group, such as the true viper, pit-vipers, and rattlesnakes, belongs to an altogether different category, causing paralysis of the heart. To fight this effectually it would seem necessary to prepare from vipers' venom a serum analogous to Calmette's antivenin; and until this be discovered, only empirical methods of counteracting the effects of the poison can be employed.

* * *

The Supply of Ivory.

During a recent visit to the London Docks, Her Majesty the Queen was informed that the stock of ivory then shown represented, on an average, the annual slaughter of some 20,000 African elephants. This statement has been contradicted in two letters in the daily papers. In one of these Messrs. Hale, of 10, Fenchurch Avenue, state that at least 85 per cent. of the supply is "dead ivory," mainly obtained from hoarded stores of the African native chiefs, who are shrewd enough to put their commodities on the market only in driblets. The most interesting part of the letter is, however, the statement that the great bulk of this hoarded ivory is obtained from "elephant cemeteries"—spots met with here and there in the jungle where elephants have resorted for centuries to die. Much of the ivory that comes to the market may, therefore, according to this letter, be several hundred years old. The marvel is why it is not devoured in the jungle by porcupines, as certainly happens with tusks of the Indian elephant which are left in the jungle. The letter adds that very little ivory is now obtained by hunters.

* * *

Popular Economic Zoology.

The following is culled from the "Woman's Column" in a recent issue of a local paper: "There are two divisions of pearls, the Oriental, by far the most valuable, and the baroque. The latter are embedded in shells, and have to be cut out—a process at once difficult and delicate, needing to be performed by very practised workers. The Oriental, of course, are found in fish. The pearl, although one of the most beautiful of jewels, and a particularly dainty gem, has a curious origin. It is formed by the saliva of fish, and it is supposed that a grain of sand, perhaps, or some other equally irritating foreign matter, has caused the fish discomfort, and it has covered the sore with saliva, pursuing the process continually until a pearl of considerable size becomes formed. This is proved by the fact that when a pearl is cut in half always a small speck is found in the centre." And this in an age when we have technical education and science lectures all over the country, to say nothing of special memoirs on the origin of pearls in various scientific journals!

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Striped Hawkmoth in England.

In his "British Moths," published in 1874, the late Edward Newman, in describing the species known as the striped hawkmoth (*Dilephila livornica*), stated that most of the specimens alleged to be British were really of Continental origin, but that there were a few undoubted British examples of this beautiful moth. According to the *Entomologist* for June, the present year will be notable for the number of specimens of this species taken in this country, no less than eight being recorded in that issue. The localities where these captures were made are Carlisle, Yelverton (near Plymouth), Wormwell (near Dorchester), Marsemoor (near Gloucester), Bournemouth (where another specimen had been taken earlier in the year), Brockenhurst, and the Isle of Wight (2).

* * *

A Link between Birds and Reptiles.

It is a well known fact that in certain groups of birds—notably the petrels and albatrosses—the horny sheath of both the upper and lower half of the beak is composed of several distinct pieces. In a communication to a Swedish Zoological journal (*Arkiv for Zoologi*, vol. i., p. 470), Dr. E. Lonnberg identifies these elements with certain scales to be found on the head and lower jaw of lizards and other reptiles. If these conclusions be well founded, we have another link in the chain connecting birds with reptiles.

Botanical Notes.

By S. A. Skan.

The genus *Begonia*, in some of its numerous representatives, is met with nearly everywhere where plants are cultivated, and though differing very markedly in their vegetative characters, all its species are generally easily recognised by their flowers. When the order Begoniaceæ was elaborated for Bentham and Hooker's *Genera Plantarum*, the number of species of *Begonia* known was about three hundred and thirty, natives of the warmer parts of Asia, Africa, and America. One of the most recent additions to the genus is dealt with by Dr. Trelease in the *Fifteenth Annual Report of the Missouri Botanical Garden*. The new species, appropriately named by Dr. Rose *Begonia unifolia*, is remarkable in possessing only one leaf. It belongs to the tuberous-rooted group, and its scape, bearing a few, rather small, nearly white flowers, arises from the sinus of the single rounded leaf. The plant is peculiar in its habitat, for it was found growing on rocks, with its roots penetrating into crevices; and the large leaf is closely adpressed to the surface of the rock, serving an important function in protecting the lower portions of the plant. It is a very distinct species, having only one close ally, *B. monophylla*, a little known plant from New Spain.

The United States Department of Agriculture has recently issued a useful bulletin, by Dr. G. T. Moore and Mr. K. F. Kellerman, on "A Method of Destroying or Preventing the Growth of Algæ and certain Pathogenic Bacteria in Water Supplies." The presence of Algæ in water frequently causes trouble, and many of the methods recommended for getting rid of it are impracticable, inasmuch as their adoption would spoil the water. According to the writers mentioned above, "it has been found that copper sulphate, in a dilution so great as to be colourless, tasteless, and harmless to man, is sufficiently toxic to the Algæ to destroy them or prevent their appearance. A solution of one part of the sulphate to about 50,000,000 parts of water has been found fatal to *Spirogyra*, and one part to 4,000,000 appears to be destructive to the blue-green Algæ."

* * *

In an interesting paper by Prof. D. H. Campbell in *Torreya* for June, on the "Resistance of Drought by Liverworts," which are usually considered to be moisture-loving plants, attention is drawn to the remarkable vitality exhibited by the fronds of the "gold back fern," *Gymnogramme triangularis*, which grows in the neighbourhood of Stanford University, California. In the resting season the fronds of this fern do not die down, as is commonly the case in ferns, but they dry up and persist, and to all appearance are dead. However, on placing such a frond in water its freshness and activity are quickly restored by the absorption of water through its superficial cells. The prothallia of this fern are able to survive complete drying up. Some were allowed to remain perfectly dry during the whole summer of 1903, and on receiving water in the autumn produced numerous young plants. Prof. Campbell refers to certain devices in Liverworts for preventing excessive loss of water during periods of drought. In some the growing point is protected by hairs or scales, which sometimes secrete mucilage; while the life of others is continued by the development of tubers, which, being more or less subterranean, are less influenced by a dry season.

The British Association.

In a fortnight's time, at Cambridge, the British Association will once more engage in its annual tournament of meetings and discussions, and the swing of the scientific and social pendulum will proceed for a week as smoothly and hospitably as loyal endeavour can ensure. That the Right Hon. A. J. Balfour will deliver an address as the in-coming president, is a circumstance which must naturally lend distinction and *éclat* to the congress.

So long is it since the Association met at Cambridge, that it is permissible to indulge in a brief retrospect in order to call up from the past some of the doings of the former gathering. The last occasion of meeting in the university town was in the year 1862, under the presidency of the Rev. Prof. Willis, F.R.S., Jacksonian Professor of Natural and Experimental Philosophy. The Association was then holding its thirty-second meeting, while it now inaugurates its seventy-fourth. Among the presidents of sections was Prof. G. Gabriel Stokes, who filled the office for Mathematics and Physics, and it was at this meeting that the late Master of Pembroke presented his valuable report on Double Refraction. Mr. Francis Galton—happily still among us—was president of the section appertaining to Geography and Ethnology. Huxley, too, was there, presiding over the proceedings of Section D. Tyndall discoursed on the Forms and Action of Water. Sir Rutherford Alcock, in Section E, read a communication on the civilisation of Japan, of which it is interesting to note that his pregnant sentences stand forth to-day in honour of Japanese progress. The race might tell us with truth, he said, that for centuries they had had under their own laws, customs, and institutions, a degree of peace, prosperity, and freedom from foreign wars which no country in Europe had enjoyed during any century of its existence. They were possessed of so many excellent qualities and such an aptitude for a higher civilisation than they had yet attained, that within a very few years not only might we see them make a great and unexampled advance, but reach a trade development to which it was really difficult to fix any limit. Sir Roderick Murchison read a letter from Livingstone, dated Shupanga, River Zambesi, informing him in pathetic terms of the death of his wife, and the darkened horizon it occasioned. The attendance at the congress reached a total of 1,161.

As regards the forthcoming assembly, it is reasonable to expect that the special attractions of Cambridge, coupled with the presence of a Prime Minister, will raise the inconveniently low average of attendance which has prevailed during the past three years of the Association's meetings. Such a result was seen at its Oxford gathering in 1894, when the Marquis of Salisbury was President. Nevertheless, the British Association cannot afford to rely upon quadrennial fortune, and its friends are concerned not only to secure the adhesion of a greater number of annual members and other steady supporters, in consonance with the activities of modern science, but to improve the attendance at the congresses of the general public. There has been a steady decline in numbers in recent years. At Glasgow, in 1901, the attendance was 1,912, and the receipts £2,046; at Belfast, in 1902, they were, respectively, 1,620, and £1,644; at Southport, last year, 1,754 and £1,700, the former nearly 1,000 less than at the Southport meeting in 1883. As a matter of course, grants for scientific purposes decrease with lessened prosperity while other avenues of usefulness remain unopened. Good attendances prophesy revenue, and a satisfactory balance-sheet connotes ability to make allotments for such investigations as are deserving of recognition and help. Congressional bodies, in fact, cannot nowadays despise the legitimately commercial side of their gatherings, and the British Association in this respect should "wake up."

Certainly no one would wish to extend carping criticism to an organisation which has done yeoman's service in the interests of science and of national enlightenment. Apart, however, from the foregoing considerations, there would appear to be channels for improvement. Take, for instance, the sectional addresses. Some of these have latterly become inordinately long, and suggest limitation. Curtailment in the addresses of a President of the Association would not be good policy, nor is it required. The man of science elected to that honourable office has something to say, and should have space for his utterance. But those who fill the chairs of the sectional committees might surely give pause, and compress. The tendency is towards enlargement, and accompanying aggrandisement of type; this weighs heavily on many

men, who unwillingly rifle their brains and imagination for words, words, words. The presidential address of 1902 occupied 48 pages of the familiar brick-coloured volume. In the committees, certain presidential discourses extended to 25, 10 (two cases), and 18 pages of closely printed matter. True, there were compensations evident in a modest venture of 9 pages in one instance, and of 8 pages in another.

The one-year rule applicable to the occupancy of the presidential chair is a golden fetter around the neck of the Association. In all likelihood the distinguished men who are at present compelled to retire annually would be willing—nay, proud—to serve for a longer term, at any rate for a biennial period. Under such conditions they might reasonably hope to be of real service to the Association each in turn and according to his opportunities, with corresponding benefit to the whole organisation.

The Report of the Association, containing addresses and papers read in the sections, we take leave to say, should be in the hands of members earlier in the year. At the moment of writing, the volume for the Southport meeting, held in 1903, has not yet appeared. Perhaps it will be laid on the table at Cambridge.

Finally, may we not with advantage quote the objects of the British Association? They are:—To give a stronger impulse and a more systematic direction to scientific inquiry; to promote the intercourse of those who cultivate science in different parts of the British Empire; to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress.

[A British Association Supplement to "Knowledge & Scientific News" will be published during August.—Editors.]

REVIEWS OF BOOKS.

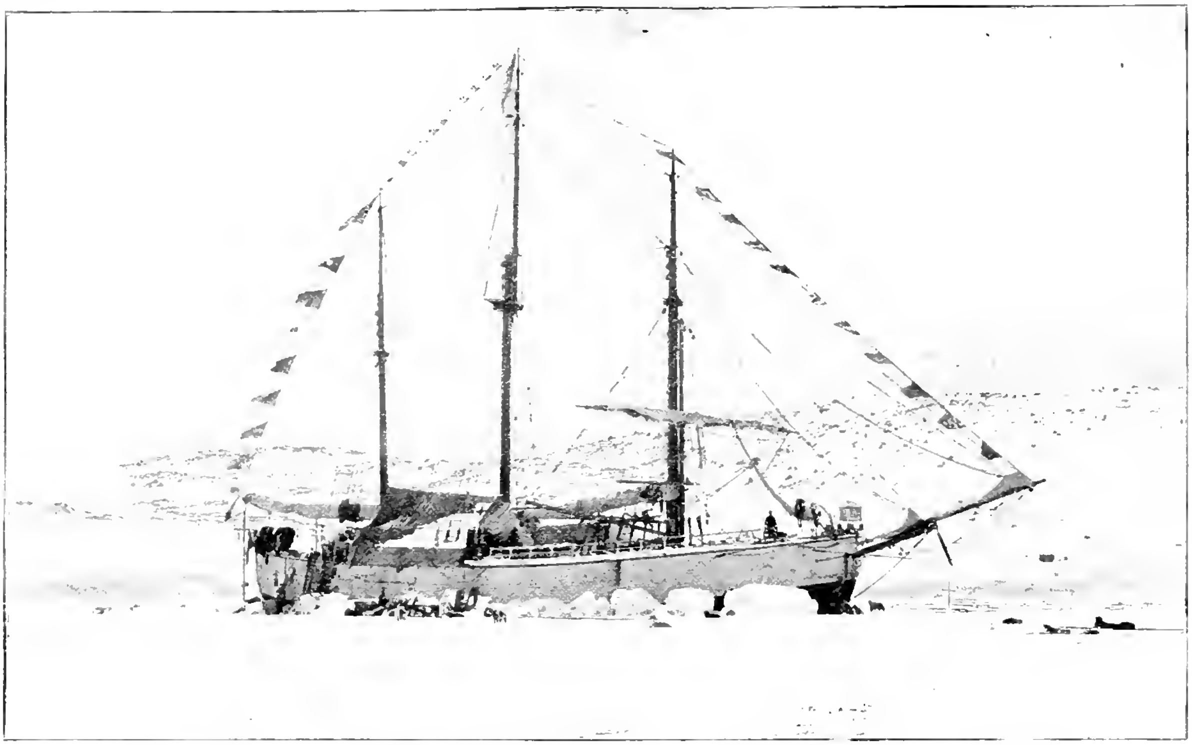
New Land.—One might well call Otto Sverdrup's history of his four years' work on the north coast of Greenland ("New Land: Four Years in the Arctic Regions," by Otto Sverdrup, translated from the Norwegian by Ethel Harriet Hearn: 2 vols.; London: Longmans, Green, and Co.; price 36s. net) an Arctic Odyssey. There is something in this book which has the space and largeness of purpose of an epic. It is a large book. It is full of detail. But through it all runs a singleness of purpose and a sense of vividness which removes it far from an impression of travel, a record of exploration, a summary of achievement, and places it before one as a human document. The story of four years of the life of brave and earnest men who were hemmed in by the harshest of Nature's conditions—in journeyings often, in sickness often, in hunger and thirst often, in perils often. It is on this aspect of the volume that we would soonest enlarge. Their scientific value as an addition to the knowledge of the Polar seas and land is admitted and established; and they occupy a place by right on the bookshelves of the geographer, the naturalist, the geologist, and the meteorologist. But, as Lord Kelvin said when some years ago the question of an Antarctic expedition was first mooted, the best ground on which to appeal for help for such work is the ground of "exploration." That word has a magic for people to whom scientific results are of little import; and "exploration" of that fascinating kind in which the explorers seem real people of like passions and weaknesses with ourselves is to be found at its best in Captain Otto Sverdrup's tale. Its introduction is characteristic. Says Captain Sverdrup: "A few days after our return from the first Norwegian Polar Expedition, we were lying in Lysaker Bay unloading the *Fram*, when Dr. Nansen came on board. 'Do you still wish to go on another expedition to the North?' he asked me. 'Yes, certainly,' I answered, 'if only I had the chance.' He then told me that Consul Axel Heiberg and the firm of brewers Messrs. Ringnes Brothers were willing to equip a new scientific expedition with him as leader. The Norwegian Government gave the *Fram*, and added £1100 to the cost of the enterprise. As an exploratory expedition, the main object aimed at was the investigation of the North Coast of Greenland by way of South Sound and Robeson Channel, and the determination of the island character of Greenland. The captain was to have a free hand, and there was no question of reaching the Pole. They were to go for two or three years; but after passing their third winter at the head of Goose Fjord, they looked forward to release; in the summer they still found themselves ice-bound. In the summer of 1901 they advanced a distance of only nine miles, and five miles of an impenetrable barrier still stretched between them and the freedom of the open sea. It was not till August, 1902, that the *Fram*, having broken the bonds of her long imprisonment, reached Norway, and received the welcome that the Norwegians and the whole world was ready to give them. The expedition had been a great success, and geographically it had added greatly to our knowledge of the Peary Archipelago; had established an outlet from Hayes Bay; had delimited to the west Ellesmere Land, Grinnell Land, Grant Land; and had brought back many valuable geological, botanical, zoological, and meteorological data—all of which are tabulated and summarised in the capitally translated and beautifully illustrated volumes that Messrs. Longmans have published.

But, as we have said, the charm of this work for the general reader lies in the manner of Captain Sverdrup's telling. He has the sailor's gift of telling a good yarn. Quite early in the frozen solitudes of the north he encountered a fellow explorer—a meeting of which we realise alike the strangeness and unexpectedness. It was Lieut. Peary, whose ship had been ice-bound off Cape Hawkes. But he only stopped a few minutes for all the world as if they had met on a suburban station platform with trains to catch. He would not even stay to take coffee. "I took Peary down to the sledge, and watched him disappearing at an even pace, driven by his Eskimo driver. . . . . We talked of nothing else, and rejoiced at having shaken hands with the explorer, even though his visit had been so short that we had hardly had time to pull off our mittens." The incident is briefly told, but it is wonderfully vivid; as vivid as that unconscious word-picture that Sverdrup draws of his vessel in its ring of ice and silence: "There lay the *Fram* stout and defiant like a little fairy house in the midst of the Polar night." It is in this little fairy house that the four years homely epic of travel takes place. It is here the Doctor dies, and is buried with tears and prayer. It is here that they have their merrymakings; their procession with banners on Constitution Days (May 17th); their newspaper, "*The Friendly One*," and their Christmas festivities. Do you wish to learn how gay and natural a touch there is in this book; you will find it it in the pages that tell of Christmas Day. "When the Christmas tree was brought in, everybody was quite silent for a moment—and then the merriment broke loose in earnest. As it stood there, with its glittering gold and silver tinsel, and its red and white candles, in the midst of our darkness here, it seemed to be a greeting from home and from above. It seemed as if we were being told that there was still life, and that the light was not really gone. We thought that we were sitting amid our dear ones, could take them by the hand, could feel that they really lived; it was as if happy thoughts had been sent to us—and thus we had to shout for joy and make a horrible noise, much worse than our four-footed friends outside in the snow. And what was a sob within us found expression in a terrible hubbub, especially when all the Christmas presents were undone. They were chiefly children's toys—for men who felt like children! Drums, trumpets, fireworks, dolls, Noah's arks, sneezing powder, scratching powder, marzipan pigs, and things of that kind. There was merriment beyond compare, and practical jokes without end."

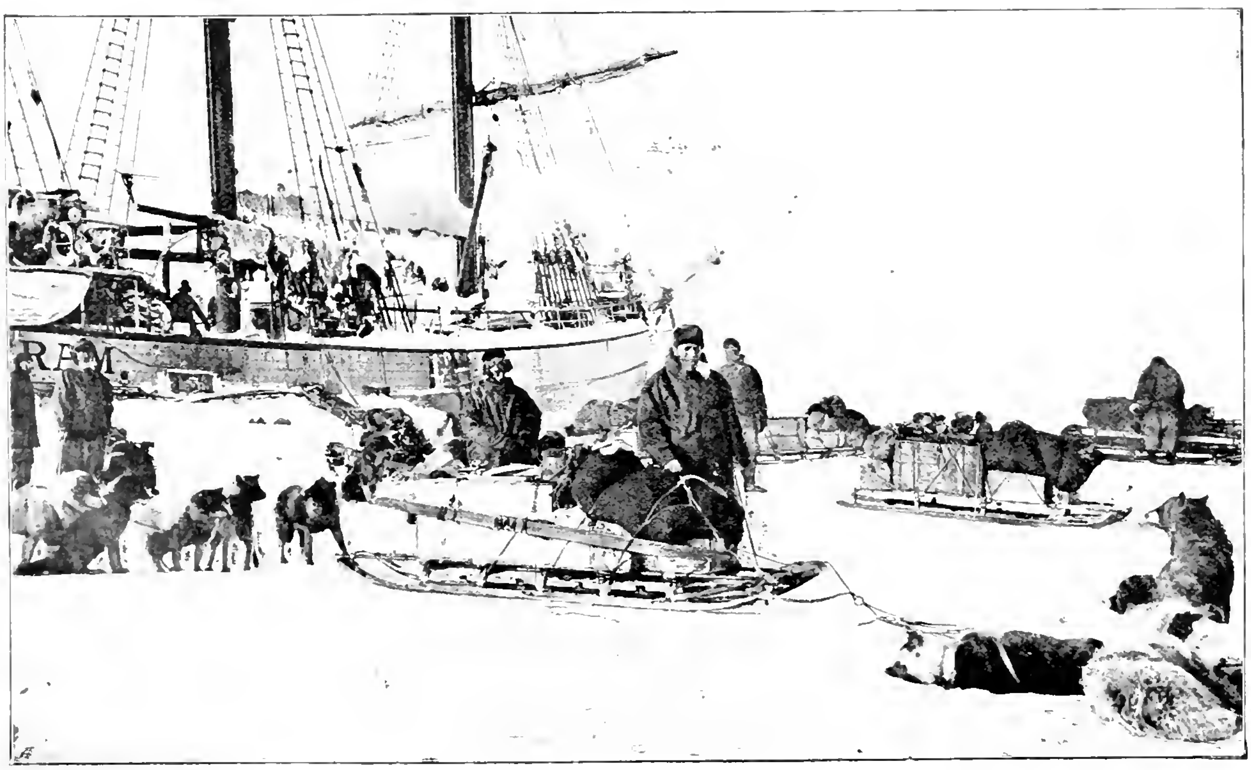
It was not all simple gaiety among the travellers. The death of the doctor, followed by another death, plunged them presently into depression, a depression deepened by their comparative ignorance of medicine and the obsession for the "oncoming Polar night." But when one of the crew dislocates his shoulder, the accident, though serious, maintains in Sverdrup's pages a cheerful view. There is a good deal of humour in it.

"What had we better do for Olsen's arm? We found some diagrams and various directions as to how a dislocation should be reduced, and after some consideration, chose the way which seemed the easiest and most simple. The opera-

tion would have been easy enough had we dared to chloroform our patient, but we had no desire to attempt such a thing. Several days had elapsed and the arm was swollen and angry. for *that* we could better grapple with. For this purpose we first tried naphtha, but that did not do; he disliked the taste of it so much that I could not bring myself to force it on him.



The Fram in Winter Quarters.



CAPTAIN SVERDRUP.

Start for the Journey.—Spring, 1901.

Inexperienced as we were we should probably torture poor Olsen most horribly before we got his arm into place again. I therefore decided to make him thoroughly drunk—the effects We had things that tasted considerably better. I sent for a bottle of the very best cognac, and began to give him dram after dram. But it really was too much to expect him to drink

himself half seas over in dry nips all alone, without any other diversion, so I sat down and talked to him about everything I could think of. At first he was very much taken up with his arm, but from that we went on to the expedition in general, then to shooting in general, and lastly, after innumerable excursions landed, in the Lofoden Islands in which he was patriotically interested. In this way I brought him little by little into brilliant spirits. He grew livelier at every dram. Fosheim and Simmons, who had been chosen for the deed of bone-setting, sat awaiting the propitious moment, following with much excitement his various stages of development during our potations, while I talked myself blue in the face to get him to drink more and bark on the crisis. It was not long before Olsen himself began to be highly pleased at the whole performance, declaring it was the most amusing entertainment he had ever taken part in. When he had swallowed about half a bottle of brandy we thought he must be about ripe to be taken. We accordingly placed him on a chest, and the bone-setters began their work, but no, the collar would not go in . . . . at last, however, we heard with unspeakable relief the crack of the arm as it slipped into its socket. As for Olsen, notwithstanding all he had taken down, it had not much effect on him. While we were doing our work, the pain and excitement had kept him sober, but the instant the arm was in its socket he became dead drunk." The operation in the result proved quite successful. We have not space for further extracts from this deeply interesting book. We may say of it in conclusion that its interest and value arises from its essentially human aspect. Even the dogs become the reader's as well as the writer's friends; and Sverdrup gives us some quite new views about the Eskimo. In short, he is a shrewd observer, a kindly critic, a good writer, and a man to the backbone. His book is worthy of him.

Zoological Notes for instruction in schools, of a kind which is likely to attract as well as to instruct children, are being published by Messrs. Asher and Co., of Covent Garden. The plates, large in size and printed in colour, are German in origin and manufacture (Schroder and Kull's Biological diagrams), and if, on the one hand, they are wanting in artistic feeling, the amount of information they convey of the characteristic surroundings, occupations, attitudes, anatomy and allied species of the animals pourtrayed is surprising. It is probable that such plates leave a stronger impression on a childish mind than others more artistic or more photographic.

"Our Country's Animals" (Simpkin, Marshall, Hamilton, Kent and Co.), by W. J. Gordon, is one of a very useful popular series of Natural History. Each volume is illustrated with coloured plates, so that the amateur observer of Nature in country rambles may be able to identify the stoat that runs across his path, the field-mouse that rustles away into the hedgerow as he passes, or the water-rat that his coming startles into diving from the bank into the stream. He may learn, besides, something of their species, habits, and characteristics.

"The Nature Library" (Fisher Unwin). "Quiet Hours with Nature," by Mrs. Brightwen, is in part republished from the "Girl's Own Paper." The author's loving observations of bird and insect life are prettily and sympathetically recorded; and her book is as pleasant to read as it must have been to write.

"Nature's Story of the Year," by Charles A. Witchell, of the same series, also records his observations of Nature, though in a less sympathetic spirit. No true lover of Nature could shoot a bullfinch in cold blood because it attacked his fruit trees. His book nevertheless contains much that is interesting.

"A Modern Zoroastrian" (Watts and Co.), by Samuel Laing, deals with scientific and moral questions, and proceeds from the study of ether and energy to consideration of religions and philosophies. It is addressed to the general reader.

"Ethics of the Great Religions" (Watts and Co.), by Charles T. Gorham, is a useful survey of the principal religions of the world, and the features they have in common.

"The Ethics of the Dust" (George Allen, pocket edition). In this little book, which was written in the form of graceful and fanciful conversations with children, Ruskin attempted to explain some of the principles of mineralogy and to awaken an interest in the study of the subject.

"The Lion Hunter" (John Murray), by Hon. Aleyn Gordon Cumming, which appears in a new edition, is the record of five years' adventures in the interior of South Africa, covering a period which began as long ago as October, 1843, so that the writer traversed much of what was then unknown country.

BOOKS RECEIVED.

Geography. We have received for review the ninetieth edition of Dr. James Cornwell's "School Geography" (Simpkin, Marshall, Hamilton, Kent, and Co.). This comprehensive and clearly-arranged text book should be useful to teachers. Its facts are judiciously selected, and the information given about each country is divided under the heads of physical and political geography so that the teacher's work is simplified as far as possible.

Geography for Beginners (Simpkin, Marshall, Hamilton, Kent, and Co.), by the same author, contains the principal facts in a simplified form.

Photography. Practical Enlarging (Iliffe and Sons), by John A. Hodges, appears in a sixth edition. It is intended for the use of hand camera workers, or those who make use of any small cameras. Bromide enlarging, as the most popular method, is very fully dealt with, and full directions are also given for the more elaborate methods of making enlarged negatives.

Practical Slide Making (Iliffe and Co.), by G. T. Harris, F.R.P.S., is intended to supply trustworthy information concerning all the best known methods of making lantern slide transparencies; it is clearly written, and well adapted for practical purposes, with good print and a strong binding.

Photography.—Mr. W. Jerome Harrison's "Photography for All" (Iliffe and Sons) suffers from the defects of its qualities. It is designed for the instruction of those—among others—who handle a camera for the first time; and it is sometimes too elementary. This would not be a great defect if it were up to date; but that it is not, and the ways it recommends of doing things are not always the best ways.

The Photographic Dealer's Annual (Marshall, Brookes and Chalkley) is what it aims at being—largely a trade publication. But its articles are well written and to the point; and it is an extremely useful "who's who" and "what's what" to the practical photographer.

Engineering.—The Model Engineer Series (Percival Marshall and Co.) is a series of cheaply printed and fully illustrated popular handbooks; price, 6d. each.

The Locomotive is a simply-written introduction to the study of locomotive engines, distinguishing between their different types and explaining them.

X-Rays, by R. P. Howgrave-Graham, A.I.E.E., aims at giving the student some idea of the course of experiment and discovery which led to the present state of scientific knowledge of Rontgen rays.

Static Electricity, by Percival G. Bull, M.A., Oxon., describes simple experiments illustrating electrical laws and phenomena, and deals with the various means of producing electricity; and with electrical attraction and repulsion. It is designed for the use of young students, and is very clearly and simply written.

Patents Simply Explained gives directions for the patenting of inventions and the registration of trade marks and designs.

Mechanical Drawing, by F. E. Powell, is designed as a guide to the apprentice or student, and describes the use of drawing instruments, and the "reading" of drawings; it also gives directions for preparing practical illustrative sketches.

Acetylene Gas, by Cyril N. Turner, is a practical handbook on the uses and generation of acetylene gas; and is designed to enable amateur mechanics to produce it in an inexpensive way.

We have received from Messrs. Adam Hilger, Ltd., their new list of spectroscopes and spectroscopic accessories. The list is well and conveniently arranged and the information it affords concerning spectroscopic instruments alike for general and for special work is of practical service to the investigator. The most interesting pages are those which reproduce film replicas of Rowlandson's diffraction gratings, which are ruled with 14,438 lines to the inch—a marvel of scientific handicraft; and of the Michelson echelon diffraction gratings.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Gelatin Plates as Light Filters.

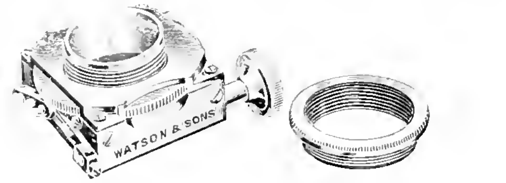
A recent number of the "Journal of the Royal Microscopical Society" gives an abstract of a method described by a German writer for making gelatin plates which may serve as substitutes for glass light-filters for microscopical and photomicrographical purposes. A solution of the best gelatin, such as is used for making dry plates, is made in the usual way, the proportion to the water being as 1 to 200. To the filtered solution 3 cubic centimetres of 1 to 50 aqueous solution of alum are added. The films are made by pouring the gelatin on a glass plate placed on a levelling stand. When quite dry the gelatin is overlaid with a film of collodion stained with some aniline dye. Red plates may be made as follows: Dissolve (1) 2 grm. aurantia in 40 c.cm. of absolute alcohol, (2) 5 grm. rose Bengal in 20 c.cm. methyl alcohol. Then mix 20 c.cm. of (1) with 10 c.cm. of (2), and add 90 c.cm. of 4 per cent. collodion. Yellow plates can be made by adding 20 c.cm. of a saturated alcoholic solution of aurantia to 80 c.cm. 4 per cent. collodion. The gelatin plates may be doubled so as to strengthen the film, or one may be placed on either side of the coloured layer. The advantage of using coloured screens when endeavouring to photograph objects stained in such a way as to give little contrast on a photographic plate is obvious to all, and expert photomicrographers depend largely upon such means of differentiating. In an early number of this magazine I hope to give a brief and elementary account of the ordinary procedure in photomicrography, mainly for those who are photographers and who wish to utilise their knowledge in order to photograph microscopic sections, but find their results unsatisfactory, through want of knowledge of a few elementary rules of procedure.

Dry and Immersion Objectives.

Several inquiries have been sent to me as to the relative advantages of dry and immersion objectives, and though the subject is adequately treated in the various microscopical text-books, a few words upon the matter may be of service. Let us assume that an extraordinarily wide-angled dry lens can embrace an angle of 170° from an object placed uncovered on the slide, though, of course, so large an angle as this is really barely possible. Then a cover-glass placed over the objective will produce a certain amount of refraction, according to the well-known law that rays of light from a medium (in this case glass) entering another less dense (in this case air) are refracted away from the perpendicular. By this refraction a large portion of the extreme rays, which ought to enter the objective, will be refracted, some being even totally reflected, and so fail to enter it. If a denser medium were to take the place of the air, this refraction would be minimised, and if it were as dense as the cover-glass, it would be practically non-existent. This resolves into the fact that an oil-immersion objective of 82°, a water-immersion of 97°, and a dry lens of 170°, all admit approximately the same amount of light. Therefore a water-immersion, and still more an oil-immersion can be made to admit light of an angle much greater than the widest angled dry lens. There is therefore a great gain of light, and with the increase of aperture there is a corresponding gain of resolving power. There is yet a further gain of working distance. There is still a further gain, sometimes overlooked, due to the fact that the intensity of the rays are less as they become more oblique, but that they increase in intensity according to the density of the medium, in a ratio, in fact, that is measured by the squares of their refractive indices. Enough has been said to show the advantage of the immersion system of objectives. It follows naturally that the term angular aperture no longer expresses the value of an objective, and thus a new system of rating has sprung into existence, due to Professor Abbe, which takes into consideration the refractive index of the medium, whether air, water, or oil, as well as the angular aperture. The formula is $n \sin u$, where n is the index of refraction of the medium in front of the objective, and u the sine of half the diameter of the emergent pencil of light at the back of the objective. This is the "Numerical Aperture," or N.A. Finally, there is yet another advantage. Any variation in the thickness of the cover-glass in a dry lens upsets the corrections of the objective, and must be corrected by a collar which adjusts the position of the individual lenses which make up the objective, or by an adjustment of tube length. Water has a refractive index nearer to the cover-glass than air, and therefore the necessary corrections are much less serious; but cedar oil has almost exactly the same refractive index as crown glass, and so there are practically no corrections required. Of course, immersion-lenses are always high powers, and equally, of course, it is not quite as convenient, and is now and again impracticable, to use such lenses. It is scarcely necessary to add that a dry lens cannot be used as an immersion lens, nor an immersion lens in any other medium than that for which it is constructed. Immersion condensers are made in order to reduce aberrations, and to enable a cone of light to be passed which is proportional to the wide apertures of immersion objectives, and with an oil immersion condenser, an oil immersion objective, and an object mounted in Canada Balsam, we have a condenser, a connecting medium, a slide, a mounting medium, a cover-glass, again a connecting medium, and finally an objective, which are, to all intents and purposes, one homogeneous whole.

Watson's "Facility" Object-Changer.

Messrs. W. Watson and Sons have sent for inspection a new object-changer of novel construction. It is square in shape and screws on to the end of the draw-tube in the ordinary way. On the under side are a pair of opposite jaws, a quarter of an inch wide, which open by means of the handle shown in the illustration, and when released engage the threads of the objective screw and carry it up to the shoulder where it



is firmly and squarely held in place. It is made of Magnalium and so is very light; it is only half an inch thick, and it provides a rapid and easy method of changing objectives. Most workers have found that they possess one or more objectives whose screws are not cut strictly to the proper gauge, and to obviate this Messrs. Watson provide rings of absolute gauge to fit such objectives, and ensure accurate gripping in the jaws of the object-changer. These rings do not interfere with the fit of the objective in its box.

Royal Microscopical Society.

June 15th.—Dr. Dukinfield H. Scott, F.R.S., President, in the chair. Mr. T. H. Powell exhibited *Pleurosigma angulatum* under a 1/16-inch, 1·35 N.A. apochromatic homogeneous immersion objective made by him. Professor Hartog exhibited a slide prepared and lent to him by Professor Vejdovsky showing the first segmentation spindle and centrospheres in the embryo of Rhynchelmis. This was so large as to be visible with a pocket lens and was distinctly shown under a 1/4-inch objective and "B" ocular. Mr. Beck exhibited a portable microscope designed by Mr. Arthur Hollick. It was daily used for the examination of botanical subjects, but was equally useful for other purposes. The mirror was so mounted that it could be used above the stage for illuminating opaque objects, swinging on a centre that was at the level of the object. An ingeniously contrived rotating cell, made of cardboard, forming a convenient revolving object holder, and a simple method of

mounting in pill-boxes were described. Another point of interest was the coming down of the objective to such size as to admit as much, and no more, light than could be utilized by the back lens; this reduction of the front of the objective facilitated the illumination of opaque objects. Professor J. D. Everett read his paper, entitled "A direct proof of Abbe's theorem on the microscopic resolution of gratings." In the subsequent discussion Mr. J. W. Gordon, Mr. Conrad Beck, and Mr. Rheinberg took part. Mr. Beck explained Abbe's experiment with a grating on the stage showing doubling of the lines by means of a triple slit in the focal plane of the object glass. This he had brought at Professor Everett's request in illustration of the paper. Mr. Rheinberg followed with some remarks on the influence on image gratings of phase difference among their spectra, which he illustrated by an arrangement he had prepared of a microscope that showed the movement of lines in the image of a grating by creating a phase difference amongst the spectra in the back focal plane of the objective by means of an Abbe glass-wedge compensator. Mr. F. W. Millett's paper, the 10th of the series, on the recent Foraminifera of the Malay Archipelago was taken as read. Mr. F. Enock then gave his lecture on "Nature's Protection of Insect Life," which was illustrated by a fine series of lantern slides of colour-photographs of living insects. The following were elected Honorary Fellows of the Society: Gaston Bonner, Jacques Brun, Yves Delage, S. Ramon y Cajal, B. Renault, J. J. Harris Teall, Sylvanus R. Thompson, and M. Treub.

Quekett Microscopical Club.

The 415th ordinary meeting of the Club was held on June 17, at 20, Hanover Square, W., the President, Dr. E. J. Spitta, V.P.R.A.S., in the chair. An unusually large number of new members were balloted for. Mr. C. D. Soar, F.R.M.S., read a paper descriptive of two new Fresh-water Mites, *Pseudofeltria scourfieldi*, discovered in Cwmm Glas, North Wales, by himself, and *Midcopsis crassipes*, found at Oban by Mr. Taverner. The President then gave an interesting lecture and demonstration "On a Method of Suiting Screens for the Photomicrography of Stained Bacteria." He was assisted by his son, Dr. Harold Spitta, who exhibited a number of lantern slides and diagrams illustrative of the method and its results, and by Mr. Conrady, who manipulated a second lantern fitted with a large spectroscope, by means of which a series of beautiful and interesting spectra were thrown upon a separate screen. After comparing and contrasting the differences between the eye and the photographic plate in the matter of colour sensation, Dr. E. J. Spitta went into a comparison of the various orthochromatic plates upon the market. By testing each plate under long and short exposures with a spectroscope, he found a wide difference in their relative sensibility to colour, a difference which he illustrated by means of photographs of the spectrum taken on each kind of plate. Having ascertained by this means the limit of their sensitiveness in the presence of colour, which he termed the "eye" of the plate, he was enabled to construct contrasting screens by means of which the maximum contrast was obtainable. Photographs of bacteria stained with Löffler's blue, gentian violet, and carbol fuchsin, the three principal bacteriological stains, were exhibited, taken with and without the contrasting screens. The results were most striking, the improvement in detail and definition being very marked.

H. W. Harvey, Norfolk.

I would suggest your getting M. C. Cooke's "Microscopic Fungi," which forms a good introduction to the study of the subject.

T. H. Asthury, Wallingford.

In answer to your query as to Mr. Warburton's article on "Mites," Mr. Warburton says he uses concentrated carbolic acid for clearing. I am aware that this sometimes leads to difficulties in subsequent mounting in Canada balsam, but Mr. Warburton says he has no difficulty with it. With regard to the parasitic growths upon *Parnus prolifericornis*, if you will send me the beetle I will see what I can do with it.

Miss B. B. Bryant, Bath.

By the blow-fly *Calliphora vomitoria* is understood. It has a yellow, golden, or white head, brown eyes, black thorax, and blue abdomen with black stripes and long black hairs. The flesh-fly is *Sarcophaga carnaria*. It has a head yellow in front, with feathery antennæ, reddish eyes, grey thorax, with longitudinal black lines, black abdomen with four square white spots on each segment, and black hairs on all the body. Dr. Sharp has kindly given me the following particulars: "By blow-flies and meat-flies I think people mean the same thing, viz., the blue *Calliphora s.* But the flesh-fly is a very different insect—a grey-striped and black insect with red eyes—*Sarcophaga carnaria*. There is rather a difficulty as regards *Sarcophaga*, because there are different species; though horribly awake they apparently differ greatly in economics, the *S. carnaria* being viviparous. As regards the blow-flies, both *Calliphora vomitoria* and *C. erythrocephala* are equally common here; one has a yellow face with black beard on it, the other a black face with yellow hairs. No doubt with most people they pass as all *C. erythrocephala*. *Sarcophaga* has the abdomen *mottled*, a sort of square pattern, it has very large pulvilli on the feet, is a quite different shape from *Calliphora*, and keeps in the country on the look out for carcases. There is still a great deal of much interest to be discovered about these common flies, which, though disgusting to most people, are physiologically at the top of the animal kingdom." "A List of British Diptera," by G. H. Verrall (2nd edition) may be procured from the author, Sussex Lodge, Newmarket. With regard to mounting flies whole, I would suggest your trying a weaker solution of potassium hydrate and longer immersion. The object of this soaking is mainly to dissolve out the contents of the abdomen, &c., after which the object is washed first thoroughly in water and then dehydrated in alcohol, and finally soaked (for a few days, if necessary) in turpentine to make it transparent, then cleared in clove-oil and mounted in Canada balsam. If this does not prove satisfactory, I would suggest treating the wings separately and mounting on the same slide, or mounting another fly dry for comparison.

A. Morley Jones, Ealing.

Your query has not reached me before, but you do not say what are the Zoophytes to which you refer. Generally speaking, the method of mounting would be narcotisation by cocaine by gradually adding a one per cent. solution to a small quantity of water containing the specimens, or killing at once by a drop of osmic acid, washing in water, staining if requisite, again washing, and finally mounting in glycerine jelly.

George Phelps, Warminster.

I am afraid the only reference I can give you on the subject of Trombidiid mites is to the article on Mites in "Carpenter." Mr. Michael's monographs in the Ray Society's publications deal only with the *Oribatidæ* and cheese-mites. The forthcoming volume of the Cambridge Natural History will have a short account of the *Trombidiidæ*, and I understand from Mr. Soar that a number of "Das Tierreich," shortly to be published will contain a full list and description of every species. As I have said to another correspondent, the literature with regard to mites is in a very incomplete state.

A. Robinson, Portsmouth.

An objective corrected for a short tube does not perform as well with the long tube; but it is so much a matter for a critical eye and critical illumination that I fear I cannot advise you how to ascertain the length of tube for which your objectives are corrected if your own work has not shown it to you. I would suggest, however, your obtaining a slide of the proboscis of a blow-fly, and, using the edge of the lamp-flame, carefully focus first the objective upon the slide, and then the lamp flame by means of the condenser, so that with a moderately low power a distinctly marked band of light lies across the field. The fine hairs on the tip of the proboscis (not the long ones on the edge) are those to be looked at, and the iris diaphragm must be shut down just enough to cut off any excess of light, and not enough to cause any thickening of the filament like points of the hairs, or any refraction rings around them. Then use the highest-powered eyepiece you have, and note whether the objective performs best when the tube is fully closed or fully extended. As a matter of fact, nearly all students' series of objectives, whether of English or Continental make, if comparatively recently made, are corrected now for the short tube.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for August.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.24, and sets at 7.47; on the 31st he rises at 5.12, and sets at 6.48. Sunspots, faculæ, and prominences have been fairly conspicuous of late.

The positions of spots with respect to the equator and poles may be derived by employing the following table:—

Date.	Axis inclined from N point.	Centre of disc, N of Sun's equator
Aug. 1 ..	11° 0′ E	5° 55′
,, 11 ..	14° 47′	6° 32′
,, 21 ..	18° 9′	6° 58′
,, 31 ..	21° 2′ E.	7° 12′

THE MOON:—

Date.	Phases.	H. M.
Aug. 3 ..	☾ Last Quarter	2 3 p.m.
,, 11 ..	● New Moon	0 55 p.m.
,, 18 ..	☽ First Quarter	4 27 a.m.
,, 26 ..	○ Full Moon	1 2 a.m.
Aug. 12 ..	Perigee (222,800 miles)	9 18 a.m.
,, 27 ..	Apogee (252,500 ,,)	4 12 a.m.

THE PLANETS.—Mercury is an evening star, setting about 8.40 p.m. on the 1st. He is in aphelion on the 17th and at greatest elongation on the 20th, hence the proximity of the time of aphelion to that of greatest elongation makes the angular distance from the sun large, and amount to 27° 24′ E; the position of the ecliptic in the evening sky at this time of the year, however, counteracts the otherwise favourable coincidence of greatest elongation and aphelion.

Venus is an evening star in Leo, setting about 7.50 p.m. on the 15th.

Mars is a morning star in Cancer, rising about two hours in advance of the Sun.

Jupiter rises about 10.15 p.m. on the 1st, and about 8.30 p.m. on the 31st. Towards the end of the month he will be the most conspicuous object in the sky about 10 p.m., looking east.

He is at the stationary point on the 20th, after which his motion is retrograde or westerly.

The equatorial diameter of the planet on the 17th is 44″·8, whilst the polar diameter is 2″·9 less.

Saturn is now well placed for observation, being a very conspicuous object in the S.E. at 10 p.m., not very high up. The planet is in opposition to the Sun on the 10th, hence this is the most favourable time for making observations of the white spots which were seen last year and used for the determination of the period of rotation, giving a value of 10 h. 38 min.

The polar diameter of the ball is 17″·4, whilst the major and minor axes of the outer ring are 43″·4 and 11″·4 respectively. The northern surface of the ring is presented to us at an angle of 15° to our line of vision.

Uranus is on the meridian about 8 p.m. near the middle of the month, when he is about 10 minutes west of the star 4 Sagittarii. His path on the borders of Ophiuchus and Sagittarius may be seen on reference to the chart appearing in the June number.

Neptune is not suitably placed for observation, rising about 5 a.m.

METEORS:—

Date.	Radiant.		
	α	δ	
Aug 10-12	45	+57	Great *Perseid* shower; radiant moving E.N.E. about 1 per day.
Aug 21-25	291°	+60°	o Draconids; bright slow meteors.

THE STARS:—

About 9 p.m. at the beginning of the month the constellations to be noticed are:—

ZENITH . Lyra (*Vega*), Hercules, Draco.

SOUTH . Sagittarius, Scorpio, Ophiuchus, Aquila: Aquarius and Capricornus to the S.E.

WEST . Boötes, Corona: Great Bear to the N.W., Virgo and Libra, S.W.

EAST . Cygnus, Delphinus, Pegasus, Aries: Andromeda and Cassiopeia to the N.E.

NORTH . Ursa Minor, Auriga (*Capella* on horizon).

Minima of Algol occur on the 14th at 11.22 p.m. and on the 17th at 8.10 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—Polaris, mags. 2·1, 9·5: separation 18″·6. The visibility of the small star is used as a test for a good 2-inch object glass.

ζ Sagittae XIX.h 45m, N. 18° 53′, mags. 5, 10: separation 8″·6.

α^1, α^2 Capricorni XX.h 12m, S. 12° 51′, mags. α^1 4·5, α^2 3·8: naked eye double, separation 373″, very easy with opera glasses.

γ Delphini XX.h 42m, N. 15° 46′, mags. 4·1, 5·0; separation 11″·8. Very pretty double for small telescopes; brighter component yellow, the other light green.

Nebulæ, &c.—Dumb Bell nebula in Vulpecula, nearly 4° due north of γ Sagittae. Rather faint object in a 3-inch.

(M 8) Cluster in Sagittarius: large luminous field of small stars: fine object in pair of field glasses. About a degree E. of the star 4 Sagittarii and near to the present position of Uranus.

MESSLER, of Berlin, Germany, and Gaumont, of Paris, France, have finally succeeded in combining the graphophone and the biograph so that perfect synchronism is attained. It is now possible to see the pictures of a cavalry drill and hear the commands as they issue from the officer's lips. A singer accompanies her gestures with the proper words and tones, creating an illusion so perfect as to make it in many cases almost impossible to believe that what is seen is not life itself. It is hoped that the invention may be so developed that it will be possible to reproduce on the screen scenes from all countries, accompanied with the appropriate sounds and languages. The educational value of such a performance would be much greater than that of the unaccompanied, silent biograph.

Knowledge & Scientific News

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Conducted by MAJOR B. BADEN-POWELL and E. S. GREW, M.A.

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CONTENTS AND NOTICES.—See Page VII.

THE BRITISH ASSOCIATION.

Presidential Address.

Sectional Addresses.

ONE of the most interesting and most largely attended meetings of the British Association during recent years began its sessions at Cambridge on Wednesday, the 17th of August. The unique position which Cambridge occupies in the history of science, and the great part which she has played in its development, joined to the attractions which an ancient University always extends to visitors, drew a representative gathering not only of British men of science, but of distinguished foreign physicists, zoologists, biologists, and economists. The Presidential address of the Right Hon. A. J. Balfour was delivered on Wednesday evening, and was heard by an audience that was as brilliant as it was crowded.

THE PRESIDENT, the Right Hon. A. J. Balfour, said that the meetings of the Association had been held for the most part in crowded centres of population where the surroundings never permitted them to forget, were such forgetfulness in any case possible, how close was the tie that bound modern science to modern industry, and that was no doubt as it should be; the interdependence of theory and practice could not be ignored without inflicting injury on both, and he was but a poor friend to either who undervalued their mutual co-operation. Yet, after all, since the British Association existed for the advancement of science, it was well that now and again the members should choose their place of gathering in some spot where science, rather than its applications, knowledge not utility, were the ends to which research was primarily directed. If that were the case, surely no happier selection could have been made than the quiet courts of that ancient university—for there, if anywhere, they trod the classic ground of physical discovery. Unless he was led astray by too partial an affection for the old university, there was nowhere to be found in any corner of the world a spot with which had been connected either their training in youth, or by the labours of their mature years, so many men eminent as the originators of new and fruitful physical conceptions. He said nothing of Bacon nor of Darwin, the Copernicus of biology, for his subject was not the contributions of Cambridge to the general growth of scientific knowledge. He was concerned rather with the illustrious physicists who had learned or taught within a few hundred yards of that spot—a line stretching from Newton in the Seventeenth Century, through Cavendish in the Eighteenth, through Young, Stokes, and Maxwell in the Nineteenth, through Kelvin—who embodied an epoch in himself—down to Rayleigh, Larmor, and the scientific school centred in the Cavendish Laboratory, whose physical speculation bade fair to render the closing years of the old century and the opening years of the new as notable as the greatest which had preceded them. What was the task which these physicists had set themselves to accomplish? Whither led their "new and fruitful conceptions?" Physics was often described as the "discovery of the laws connecting phenomena." That was a misleading expression, because the phenomena investigated were things that could not appear to beings so poorly provided with sense perception as ourselves. But apart from the linguistic error, was it not also inaccurate to say that a knowledge of Nature's laws was all we sought when investigating Nature? The physicist sought for something deeper than the laws connecting possible objects of experience. His object was physical reality, which might or might not be capable of direct perception—a reality which was in any case independent of it; a reality which constituted the permanent mechanism of that physical universe with which our empirical connection was so slight and so deceptive. If, then, one of the tasks of science, and more particularly of physics, was to frame a conception of the physical universe in its inner reality, then any attempt

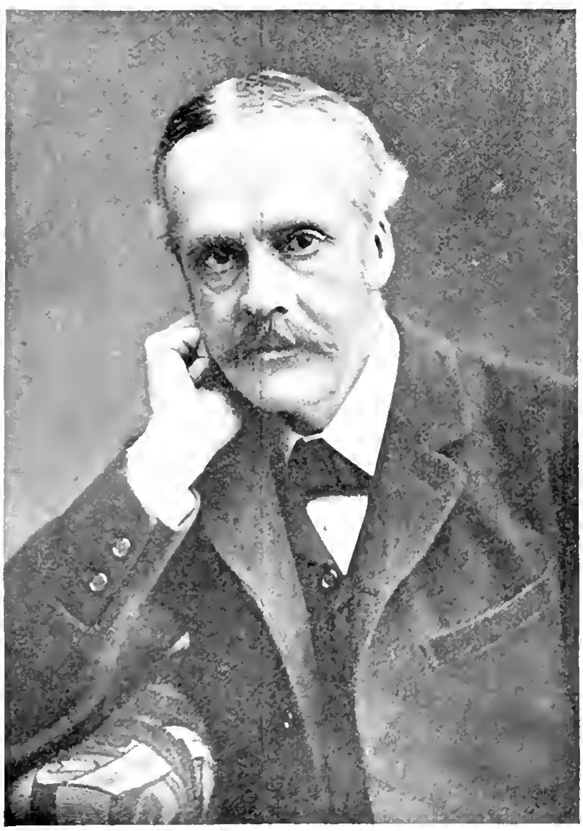


Photo. by the London Stereoscopic Co.

THE RIGHT HON. A. J. BALFOUR, M.P., President.

to compare the different modes in which from time to time this intellectual picture has been drawn could not fail to suggest questions of the deepest interest. With those which were purely philosophical the character of the occasion precluded him from dealing: with those that were purely scientific his own incompetence forbade: but there were some questions near enough the dividing line to induce one to consider them.

He would take, therefore, for his point of departure the closing years of the Eighteenth Century, a little more than a hundred years after the publication of Newton's "Principia." If at that period the average man of science had been asked to sketch his general conception of the physical universe he would probably have said that it consisted essentially of various sorts of ponderable matter, scattered in different combinations through space, exhibiting various aspects, but through every metamorphosis obedient to the laws of motion: always keeping its mass unchanged, and exercising at all distances a force of attraction on other material masses, according to a simple law. The late Eighteenth Century physicist might have added the so-called "imponderable" heat to the category of ponderable matter, together with the two "electrical fluids," and the corpuscular emanations supposed to constitute light. In the universe as thus conceived "action at a distance" was the most important form of action, the principle of the conservation of energy was undreamed of, electricity and magnetism played no great part in the whole of things, nor was a diffused ether required to complete the machinery of the universe. Within a few months of the date assigned to the hypothetical physicist came an addition to this general conception of the world designed profoundly to modify it.

A hundred years ago Young opened, or re-opened, the great controversy which finally established the undulatory theory of light, and with it a belief in an interstellar medium of which undulations could be conveyed. But this discovery was much more than the substitution of a theory of light consistent with the facts for one which was not. Here was the first introduction of a new and prodigious constituent—the ether—into the scientific world picture. Unending space was no longer thinly strewn with suns and satellites. It was now filled with a continuous medium. It gave promise of strange developments. It could not be supposed that the ether, if its reality were once admitted, existed only to convey through interstellar space the vibrations of light—the vibrations which happened to stimulate the optic nerve of man. Intended originally to fulfil that function, to that it could never be confined. It conveyed light and radiant heat and electrical waves and Hertzian waves and waves to which the human perception makes no response. But that was not all or nearly all. If we jumped the century from 1804 to 1904 and attempted to give in outline the scientific world picture as it now presented itself to contemporary speculation, we should find not only that it had been greatly modified by new laws and new discoveries, but chiefly by the more and more important part which electricity and the ether occupied in any representation of ultimate physical reality. Electricity in 1700 was no more to the philosophers than the hidden cause of the insignificant phenomena by which amber or glass, when rubbed, attracted small objects brought into their neighbourhood. It was fifty years before its effects were perceived in the thunderstorm; a hundred years before it was detected in the form of a current: one hundred and twenty years before it was connected with magnetism; one hundred and seventy years before it was connected with light and with "ethereal radiation." But to-day there were those, the protagonists of the electric theory of matter, who regarded gross matter as the mere appearance of which electricity was the physical basis. Such theorists thought that the elementary atom was itself but a collection of monads or electrons, which are not electrified matter but electricity itself—that those systems differed in the number and arrangement and relation of their electrons, and that on those differences depended the various qualities of atoms. Finally, that, while in most cases those atomic systems might maintain their equilibrium for periods that seemed almost eternal, yet they were not less obedient to the law of change than the everlasting heavens themselves.

But if gross matter was a grouping of atoms, and atoms were systems of electrical monads, what were these electrical monads? It might be that, as Dr. Larmor had suggested, they were but a modification of the ether—a modification roughly comparable to a twist or a knot in the ether. Whether that were accepted or not, it was certain that these electrical monads could not be considered apart from the ether. Their qualities depended on their interaction with it. Without it an electric theory of matter was impossible. Surely here was the most extraordinary of revolutions. Two centuries ago electricity seemed but a scientific toy. It was now thought by many to constitute the reality of which matter was but the sensible expression. It seemed possible now that it might be the stuff out of which that universe was wholly built.

Nor were the collateral inferences less surprising. It used to be thought that mass was an original property of matter: neither capable of explanation nor requiring it: in its nature essentially unchangeable: suffering neither augmentation nor diminution under the stress of any forces to which it could be subjected: unalterably attached to and identified with each material fragment. But if the new theories were accepted, those views must be revised. Mass was not only explicable, but explained. So far from being an attribute of matter, it was due to the relation between the electrical monads of which matter was composed and the ether in which they were bathed. So far from being unchangeable, it changed when moving at very high speeds with every change in its velocity. Perhaps, however, the most impressive alteration in the cosmical picture was in its view of the distant suns and their satellites—the stars visibly incandescent and in process of transformation from the nebulæ whence they sprang to the frozen darkness to which they were predestined. What of the invisible multitude of heavenly bodies in which the process had been completed? According to the ordinary view they had reached a state when all possibilities of internal movement were exhausted. At the temperature of interstellar space chemical action and molecular action would be impossible; and the stars and their constituent elements had no source of replenishment of their exhausted energy except by some celestial collision. But this view must be profoundly modified if we accepted the electric theory of matter. We could no longer hold that if the internal energy of a sun were as far as possible converted into heat which could be radiated away, then the sun's whole energy would be exhausted. On the contrary, the amount thus lost would be absolutely insignificant compared with what remained stored up within the separate atoms. The system in its corporate capacity would become bankrupt. The wealth of its individual constituents would remain undiminished. They would be side by side without movement, without affinity, yet each, however inert in external relations, the theatre of violent forces, by the side of which those that shattered a world and revealed it as a flaming new star to the astronomer's telescope were negligible.

In common with all living things, we seemed to be practically concerned with the feebler forces of Nature and with energy in its least powerful manifestations. Chemical affinity and cohesion were, on this theory, no more than the slight residual effects of the internal electrical forces which kept the atom in being. Gravitation, though it were the shaping force that concentrated nebulæ into suns and satellites, was trifling compared with the attractions and repulsions between electrically-charged bodies: and those again sank into insignificance beside the attractions and repulsions between the electrical monads themselves. The irregular molecular movements which constituted heat, on which the very possibility of organic life seemed to hang, could not rival the prodigious energy stored within the molecules themselves. Yet this prodigious mechanism seemed outside the range of our immediate interests. We lived merely on its fringe. It had no promise of utilitarian value: we could not harness it to our trains. Yet not less did it stir the imagination. Its marvels were greater than those which in the starry heavens had from time immemorial moved the worship and wonder of mankind.

The President went on to comment on the acute intellectual gratification which the theory awakened, a satisfaction almost æsthetic in its intensity and quality. It was, he said, a sentiment possibly derived from an instinct, not lightly to be ignored, in favour of the belief that the material world should be a modification of a single medium rather than a composite structure. These obscure intimations about the nature of reality deserved, he thought, more attention than had yet been given to them. That they existed was certain. The difficulty that arose was when experience apparently said one thing and scientific instinct persisted in saying another. That these new views of matter diverged violently from those suggested by ordinary observation was plain enough. No scientific educa-

tion was likely to make us in our unreflective moments regard the solid earth on which we stood, or the organised bodies with which our terrestrial fate was so closely bound up, as consisting only of electric monads. Not less plain was it that an almost equal divergence was to be formed between these new theories and that modification of the "commonsense view of matter" with which science had been in the main content to work. What was this modification of common sense? It was roughly indicated by an old philosophic deduction drawn between what were called the "primary" and "secondary" qualities of matter. The primary qualities, such as shape and mass, were supposed to possess an existence quite independent of the observer. The secondary qualities, such as warmth and colour, were supposed to have no such independent existence, being no more than the resultants due to the action of the primary qualities on our organs of sense-perception. And there, no doubt, common sense and theory parted company. Such was the theory on which science had in the main proceeded. It was with matter thus conceived that Newton experimented. To it he applied his laws of motion; of it he predicted universal gravitation.

Nor was the case greatly altered when science became as much preoccupied with the movements of molecules as it was with that of planets. For molecules and atoms were at least pieces of matter, possessed of those "primary" qualities supposed to be characteristic of all matter. But the electric theory carried us into a new region altogether. It was not content to account for the secondary qualities by the primary; or the behaviour of matter in atoms. It analysed matter whether molar or molecular into something that was not matter at all. The atom was now no more than the relatively vast theatre in which the electric monads performed their evolutions; while the monads themselves were not regarded as units of matter, but as units of electricity. So that matter was not merely explained, but was explained away. The point to which he desired to call attention was not to be sought in the divergence between matter as thus conceived and matter as the ordinary man supposed himself to know it, but to the fact that the first of those two quite inconsistent views was wholly based on the second. That was surely something of a paradox. We claimed to found all our scientific opinions on experience, and the experience of the universe was our sense-perception of the universe; yet the conclusions which thus professed to be founded on experience were to all appearance fundamentally opposed to it. Our knowledge of reality was based on illusion. The very conceptions we used in describing it to others, or in thinking of it ourselves, were abstracted from anthropomorphite fancies which science forbade us to believe and Nature compelled us to employ. An added emphasis was given to these reflections by a train of thought that had long interested him, though he acknowledged that it had never seemed to have interested anyone else.

Sense-perceptions supplied the premises from which we drew all our knowledge of the physical world. From them we learned that there was a physical world. But in order of causation they were effects due to the constitution of our organs of sense. What we saw depended not merely on what there was to be seen, but on our eyes. What we heard depended not merely on what there was to be heard, but on our ears. Now eyes and ears had been evolved by the slow processes of natural selection. And what was true of sense-perception was also true of the intellectual powers which enabled us to erect on the frail and narrow platform that sense-perception provided the proud fabric of the sciences. But natural selection worked only through utility. Our powers of sense-perception and calculation were worked out ages before they were effectively employed in searching out the secrets of physical reality. Natural selection possessed no power of prevision. Our organs of sense-perception were not given us for purposes of research, nor was it to aid us in meting out the heavens or dividing the atom; but our powers of calculation and analysis were evolved from the rudimentary instinct of the animal. It was presumably due to this that the beliefs of all mankind about the material in which it dwells were not only imperfect, but fundamentally wrong. It might seem singular to say that down to, say, five years ago our race had without exception lived and died in a world of illusion, and that its illusions were not about things transcendental or divine, but about what it said and handled, "the plain matters of fact," among which commonsense daily moved with its most confident step and its most self-satisfied smile. And that was either because too direct a vision of physical reality was a hindrance in the struggle for existence or else because with so imperfect a material as living tissue it was impossible to arrive at right vision.

If that conclusion were accepted its consequences extended to other organs of knowledge besides those of perception. Not merely the senses but the intellect must be judged by it. Considerations like these did undoubtedly suggest a certain inevitable incoherence in any general scheme of thought which was built out of materials provided by natural science alone. Extend the boundaries of knowledge as far as you pleased; draw the picture of the universe as you would; reduce its infinite variety to the all-pervading ether; trace its evolution to the point of the development of the race and the birth of the scientific handful of men who looked round on the world, and, seeing, judged it and knew it for what it was—perform all these things, and though you might indeed have attained to science, in no wise would you have attained to a self-sufficing system of beliefs. One thing at least would remain of which this long drawn suspense of causes and effects gave no satisfying explanation; and that was knowledge itself. In conclusion, the President asked the forgiveness of his audience if he had overstepped the ample boundaries within which the searchers into Nature carried on their labours. His first desire had been to rouse in those who, like himself, were no specialists in physics the same absorbing interest in what he felt to be the most far-reaching speculation about the physical universe that had ever claimed support; and if in doing so he had been tempted to show that the farther such speculations were carried the more needful it was to complete our scheme of thought by considerations not drawn from his mere examination of the inanimate world, even those who least agreed might perhaps be prepared to pardon.

Section A.—Mathematical and Physical Science.

Professor Horace Lamb, M.A., LL.D., F.R.S., was born in 1849; was Second Wrangler at Cambridge in 1872; Fellow and Assistant Tutor of Trinity, afterwards Professor of Mathematics at Adelaide (1876-1885) and at Manchester. He

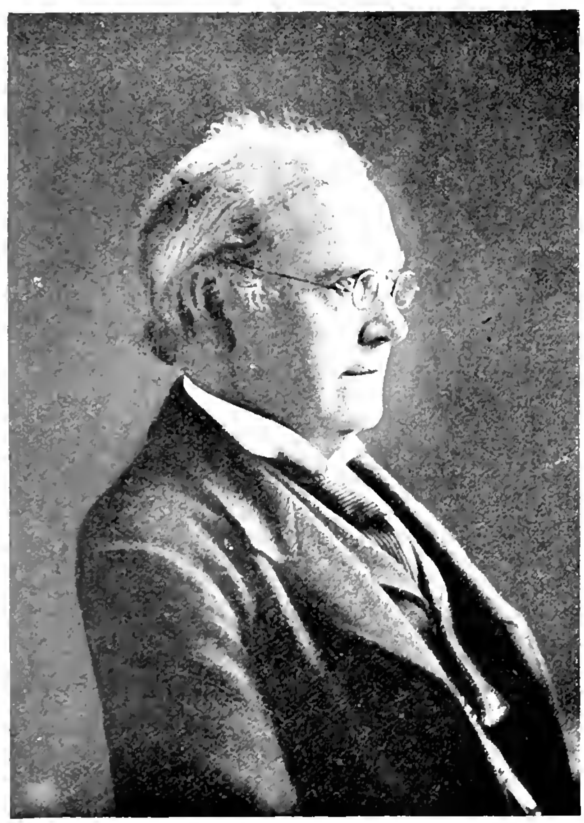


Photo. by Lafayette, Ltd.

PROF. HORACE LAMB.

has written on various branches of mathematical physics, and has published a book on Hydrodynamics. He was elected a Fellow of the Royal Society in 1884; Royal Society Medallist, 1902; and is Honorary LL.D. of Glasgow and D.Sc. of Oxford. Professor Lamb is President of the London Mathematical Society.

Professor Horace Lamb's address to the Mathematical and Physical Section was a consideration of the place occupied by the late Sir Gabriel Stokes, who took the presidential chair of the Section when last the British Association met at Cambridge, in the development of Mathematics. The aspect of Stokes' work to which attention was specially directed was its historic or evolutionary relation to the work of his predecessors and followers in that field. The review of this work led to the consideration of the question of the part which abstract conceptions played in the development of science; of the uses, for example, of theories of matter or of electricity, of the atom, of the ether, of the universe. Professor Lamb concluded his paper with a pertinent quotation from the address which Stokes delivered at Cambridge in 1862, and which was one of the shortest ever delivered:—

"In this Section, more perhaps than in any other, we have frequently to deal with subjects of a very abstract character, which is many cases can be mastered only by patient study, at leisure, of what has been written. The question may not unnaturally be asked, If investigations of this kind can best be followed by quiet study in one's own room, what is the use of bringing them forward at a Sectional meeting at all? I believe that good may be done by public mention, in a meeting like the present, of even somewhat abstract investigations; but whether good is thus done, or the audience wearied to no purpose, depends upon the judiciousness of the person by whom the investigation is brought forward."

Sub-Section.—Cosmic Physics.

Sir John Eliot, K.C.I.E., M.A., F.R.S., was educated at St. John's College, Cambridge.

1869.—Bracketed Second Wrangler. First Smith's Prizeman. Elected Fellow of St. John's College.

November.—Went out to India as Professor of Mathematics in Engineering College, Roorkha.

Photo. by Bourne & Shepherd.]

SIR JOHN ELIOT.

1872.—Transferred to Muir College, Allhabad, also as Professor of Mathematics.

1876.—Transferred to Calcutta as Professor of Physics, Presidency College, and Meteorological Reporter to the Government of Bengal.

1886.—Appointed to officiate as Meteorological Reporter to the Government of India, and in 1888 appointed permanently.

1891.—Also appointed Director-General of Indian Observatories, when the Scientific Observatories at Bombay (magnetic), Madras (astronomical), and Koodookund (solar physics), were placed under the control of the head of the Meteorological Department.

Has written numerous reports and meteorological memoirs; also a "Handbook of Cyclonic Storms in the Bay of Bengal," to serve as a practical book of reference to sailors in that area.

Chief changes in India Meteorological Department during his *régime*:—

(1.) Large extension of storm warning and flood warning work.

(2.) Large extension of area of meteorological observations, chiefly in India, Persia, and the Indian Ocean.

(3.) Large extension of work of collection of meteorological data of the North Indian Ocean and Indian area, and tabulation and publication of daily data with chart.

(4.) Unification of the rainfall; reporting systems and publication of complete annual data for the Indian Empire, &c., &c.

Also took a considerable share in the arrangements for the establishment of a Solar Physics Observatory in India, and for the commencement of a magnetic survey of India.

Sir John Eliot's address to the sub-section of Cosmical Physics dealt chiefly with that department of meteorology which has attracted most attention, and has held forth the greatest possibilities of development during recent years—the theory of weather types. Sir John Eliot's duties as an official meteorologist in India have enabled him to speak with the greatest authority on this subject; and his observations on the regularly recurring weather types of the Indian Ocean are to be regarded as the starting-point of these new methods of investigation. He divided his theme at Cambridge into two parts—(1) A Brief Sketch of the Broad Features of Tropical Meteorology in their Relations to the General Meteorology of the Indo-Oceanic Region; and (2) Illustrations of Abnormal Features of the Meteorology of that Area for the Ten Years ending in 1902. Following on the illustrations which he gave of the uses of seasonal forecasting in India—uses which are identical, in many instances, with the prosperity or the desolation of millions of people—Sir John Eliot urged the establishment of a system of Imperial meteorology. He would coordinate the meteorological system of the British Empire, and establish a central office for the investigation of problems of Imperial meteorology. The area to be dealt with on the Indo-Oceanic area was partially covered by a number of independent meteorological systems, including those of Egypt, East Africa, Central and South Ceylon, Mauritius, the Straits Settlements, and Australia. Large areas were unrepresented, and the departments controlling the systems worked independently of each other. He suggested a combined system, of which the following might be the leading principles:—

(1) The extension of the field of observation by the establishment of observatories in unrepresented areas, and the systematic collection of marine meteorological data for the whole area.

(2) The collection and tabulation of the data necessary to give an adequate view of the larger abnormal features of the meteorology of the whole area.

(3) The direction by some authoritative body of the work of observation, collection, and tabulation of data, in order to secure the use of similar methods for the thorough discussion of the data.

(4) The preparation of the summaries of data required as preliminary to the thorough scientific discussions, and for the information of the officers controlling the work of observation in the contributory areas. The earliest publication of the data should be regarded as essential for use of offices issuing seasonal forecasts.

(5) The scientific discussion of all the larger abnormal features in any considerable part of the area and their correlation to corresponding or related variations in the remainder of the area by a central office furnished with an adequate staff.

(6) Possibly, sufficient authority on the part of the central office to initiate special observations required for the elucidation of special features for which there are no arrangements in the general work of the various systems.

Section B. Chemistry.

PROFESSOR SYDNEY YOUNG, D.Sc., F.R.S., is the third son of Mr. Edward Young, of Liverpool, and was born on December 29 at Farnworth, near Widnes. He entered Owens College in 1870, becoming an Associate of the College in 1880, and in the same year was awarded the Scholarship in Chemistry in the B.Sc. final of London University. He proceeded to his D.Sc. degree three years later. At Owens College he

Photo. by Elliott & Fry.]

PROF. SYDNEY YOUNG.

conducted an investigation on "Alcoholic Thiorides," and at the University of Strasburg, where he spent a year in Professor Fittig's laboratory, he carried out researches on "Ethylvalero-lactone" and other compounds. In 1882 Dr. Young was appointed Lecturer and Demonstrator of Chemistry in University College, Bristol, and during the following five years he was engaged in original work, chiefly in physical chemistry, jointly with Professor Ramsay. On Professor Ramsay's migration to London and occupation of the Professorship of Chemistry at Gower Street, Dr. Young was elected to the Chair of Chemistry at University College, Bristol. He was elected a Fellow of the Royal Society in 1893, and is a Member of the Council of the London Physical and Chemical Societies. He was appointed last October to the Chair of Chemistry in Trinity College, Dublin, in succession to Professor Emerson Reynolds; and this year, as an old Associate of Owens College, Manchester, received the B.Sc. degree of the new Victoria University. His important work on "Fractional Distillation" was published last October.

Professor Sydney Young's Presidential address to the Chemical Section was a review of the state of knowledge of the chemical properties of mixtures, beginning with a summary of Kopp's work during last century on the molecular volumes and boiling points of chemical compounds and ending with the researches of Professor Kuenen. Professor Young defined the investigations of the behaviour of liquids when mixed together as referring to (a) their miscibility, infinite, partial, or inappreciable; (b) the relative volumes of the mixture and its components; and (c) the heat evolved or absorbed; and he went on to outline the modes of investigation applied to these phenomena.

Section C. Geology.—Earth Sculpture.

MR. AUBREY STRAHAN, F.R.S., M.A., F.G.S., District Geologist on the Geological Survey of England and Wales; born London, April 20, 1852. Educated at Eton and St. John's College, Cambridge.

Publications.—Geological Survey, Memoirs on Chester, Rhyl, Flint, Isle of Purbeck and Weymouth, South Wales Coalfield, and contributions to scientific journals.

Photo. by C. Brogi.]

AUBREY STRAHAN.

Mr. Aubrey Strahan's address to the Geological Section was an attempt to outline the Earth Movements and Earth Sculpture, gradual or cataclysmic, which resulted in the geological formations and the external landscape of the British Isles as now known. With such a history, he concluded, and with the knowledge that mountain ranges had been built in other parts of the world by upheavals of almost recent date, they had more cause to wonder that the internal forces of the globe had left this region for so long, than reason for believing that such phenomena had ceased. Slow changes of level were still occurring; and these might be the outward manifestation of more complicated movements in progress at a depth. The President offered a conjecture as to what appearance the globe would have presented had it not been enveloped with an atmosphere and covered for the most part with water. If these had not existed, the old scars, caused by the belts of crushing and buckling, would have remained, unsoftened by denudation, uncovered by sedimentation. The Earth would then have appeared to the inhabitant of another

planet as encompassed in a network of fine lines; and one was prompted to ask whether our astronomers distinguished in any other planet markings attributable to this cause.

Section D. Zoology.

William Bateson, M.A., F.R.S., Fellow of St. John's College since 1885. Born Whitby, 1861, son of Rev. W. H. Bateson, D.D., Master of St. John's College; married Beatrice, daughter of late Arthur Durham, Senior Surgeon to Guy's Hospital (1890). Educated Rugby School and St. John's College, Cambridge. Balfour Student 1887-1890.

Publications.—Materials for the Study of Variation, 1894; Mendel's Principles of Heredity, 1902.

Mr. William Bateson, F.R.S., took for his address to the Section of Zoology a subject with which his name has long been conspicuously identified—"The Facts of Heredity and of Variability of Species as Exhibited by the Practical Examination and Experiment of 'Breeding.'" The breeding pen was to the zoologist, said Mr. Bateson, what the test tube was to the chemist, and he insisted that the investigation of the problems of heredity by experimental methods offered the sole chance of progress with the problems of evolution. When Darwin wrote his "Origin of Species," that work which crowned the great period in the study of the phenomena of species, seemed to be, paradoxically enough, the signal for a general halt. The treatise brought the origin of species fairly within the grip of human intelligence for the first time, but, perhaps because it seemed to imply that the specific differences in species were brought about only by the lapse of immense periods of time, it turned men's thoughts to other subjects that were more amenable to the limits of a human life's investigation; and so the wide field from which Darwin drew his store of facts had remained for some forty years unexplored. Mr. Bateson went on to examine the corollaries to the Darwinian hypothesis which other theories had constructed. Among them, for instance, was De Vries' theory of mutations—by which species at a certain period in the long history of their generations become imbued with a tendency to change—and of greater importance to the student of heredity were the laws due to the investigatory genius of Mendel. The general conclusion to which investigation appeared to point was that Nature exercised selective operations no less potent than those which man put into operation in his experiments in breeding. In more scientific language, the true corollary to Virchow's aphorism that every living cell sprang from a living cell, was that "Every variation from type is founded on a pathological accident." In conclusion the President stated the limitations of the knowledge of heredity. "There are others who look to the science of heredity with a loftier aspiration; who ask, Can any of this be used to help those who come after to be better than we are—healthier, wiser, or more worthy? The answer to this question is *No*, almost without qualification. We have no experience of any means by which transmission may be made to deviate from its course; nor from the moment of fertilisation can teaching, or hygiene, or exhortation pick out the particles of evil in that zygote, or put in one particle of good. Education, sanitation, and the rest, are but the giving or withholding of opportunity."

Section E.—Geography.—Mankind and Mountains.

Mr. Douglas Freshfield, F.R.G.S., has supplied us with the following particulars: Born 1845. Travelled first in Alps 1854; was constantly taken there by parents and imbibed tastes for mountains early; climbed Mont Blanc 1863, made long journey including many "new" peaks and passes in 1864, recorded in "Thonon to Trent," privately printed journal, now rare. Visited Caucasus after journey in Syria in 1868 (described in "Travels into Central Caucasus and Bashan"); ascended for first time Elbruz and Kasbek, returned to Caucasus in 1887 and 1889, ascending Tetnuld and other peaks; crossed Caucasus eleven times by eight different passes (see "The Exploration of the Caucasus," a luxurious book illustrated by Vittorio Sella; visited Sikkim in 1899 and made first tour of Kangchenjunga penetrating Nepalese valleys and crossing a pass of over 20,000 feet after the heaviest snowfall ever known in that region (see "Round Kangchenjunga"). My Alpine tours are recorded in "The Italian Alps," 1875. I was for some years, in succession to Sir Leslie Stephen, editor of the *Alpine Journal*; have been President of the Alpine Club; was for thirteen years an Hon. Secretary of the Royal Geographical Society, and am now Chairman of Committee of the Society of Authors, President of the Society of Geographical Teachers, and Treasurer of the Hellenic Society. I edited two editions of the Royal Geographical Society's "Hints to Travellers" and also two editions of "Murray's Handbook to Switzerland," and have contributed to the Badminton Library and various periodicals. I know, besides, the Alps, Norway, Italy, Corsica, Algeria, Spain; travelled in Greece this spring and climbed Taggetus and Parnassus.

My father was one of the solicitors to the Bank of England. I am a landowner in Sussex. I had a large share in remodelling the publications of the Royal Geographical Society, and have worked for the improvement of maps, ordnance and private, in this country.

Have written articles on historical subjects connected with mountains, "Pass of Hannibal"; and physical, "The Conservative Action of Ice." I received in 1893 one of the gold medals of the Royal Geographical Society and a gold medal at the Paris Exhibition, 1900, for my "Exploration of the Caucasus."

Mr. Douglas Freshfield's address to the Geological Section, "Mankind and Mountains," was highly historical in its survey of the place which mountains occupy in Nature, and their influence, both spiritual and material, on mankind; but it raised several points of topical interest, including the topography and physical peculiarities of the Himalayas; the period of shrinking and advance of the Swiss glaciers with their hypothecated reference to sun-spot periods; and the question of the influence of mountain heights on respiration and physical endurance. The President remarked that the advance to Lhasa ought to throw much light on this subject. The experience of most mountaineers in the last few years had tended to modify the belief that bodily weakness increased more or less regularly with increasing altitude. Mr. White, the Resident in Sikkim, and Mr. Freshfield himself both found on the borders of Tibet that the feelings of discomfort and fatigue which manifested themselves at about 14,600 to 16,000 feet tended to diminish as they climbed to 20,000 or 21,000 feet.

Section F.—Economic Science and Statistics.—Housing the Poor.

Professor William Smart, LL.D., has been kind enough to supply us with the following biographical particulars which he very modestly, but quite wrongly, supposes are "not of much interest."

"When a student I broke down through overwork; and, giving up all hope of a professional career, entered my father's business, where I remained for some 15 years, going through all the stages, from office boy to commercial partner. My firm was one of the Clark's, now incorporated with the great thread 'combine' of J. & P. Coats. The factories were in Glasgow and New Jersey, and so I obtained that knowledge of practical manufacturing under Free Trade and under protective conditions which, as one may imagine, has done me some little service in my last book, *The Return to Protection*.

"It was at my initiative that the Glasgow Municipal Commission on the Housing of the Poor was constituted two years ago, and my presidential address reflects the experience gained thereat.

"I need only add, I think, that the Adam Smith Chair in the University of Glasgow was founded in 1896, and that I am the first occupant of it. I am a Doctor of Philosophy of Glasgow and an LL.D. of St. Andrews."

Professor Smart, addressed the Section on some of the problems of housing the poor, on which, as a member of the Glasgow Municipal Commission, he had been engaged in examining during the last two years. That Commission arose out of the necessity which had presented itself, contingent on the extensive demolition of insanitary and unsuitable dwellings in Glasgow, of housing the poor whom the extensive municipal operations were turning out. It inquired into the causes of overcrowding; the remedies to be adopted in curing and preventing overcrowding; and the important

problem of the extent to which the municipality was justified in itself building and owning houses for certain of the poorer classes. Professor Smart's address considered mainly the building and owning of houses as a branch of municipal activity, and examined the particular circumstances which

Photo. by T. & R. Annan & Sons.]
PROF. WILLIAM SMART.

might suggest a revision or relaxation of existing principles. Taking the question of principles first, he pointed out that for a municipality to add a new competitive industry to its activities was a serious matter from three points of view. In the first place, house-owning was a business of a special kind and one in which success was not certain. In the second place the municipality entered into direct competition with its own ratepayers, and that in a way quite distinct from the case in which a municipality might provide *all* the water, gas, electricity, or tramway service which its citizens might demand. In the third place, the municipality, by pledging the public credit for a new debt, was probably preventing, immediately, or in the future, the expansion of municipal activity in other directions. These considerations were not decisive against municipal housing, which in some respects was as necessary for the protection and encouragement of the community as the provision of gas or water. For example, a sanitary and comfortable house among quiet neighbours was a direct condition of the efficiency of labour and was quite definitely one of the factors of wage-earning. In other words, a good house, as compared with lodging in a slum, brought with it the possibility of paying for it. The point which especially suggested municipal house-owning was that municipal control over certain classes of houses was necessary in wage-earners' interests. But while the attractiveness of a clean city, to be by these means secured, was one thing, the attractiveness of low rents, which to the poor man's mind was an equally large consideration, was quite another. Was a municipality, in its desire to provide a clean city, to provide also low rents at the expense of the general ratepayer? Professor Smart drew attention at this point to the two propositions usually made on this head: the first, that there was a class which could not afford to pay the higher rent; and the second, that that was a valid reason for the municipality providing them with a lower one. With regard to some people alleged to be unable to pay the higher rent, he again urged that the improvement in their surroundings would make them better wage-earners; with regard to other people, to whom this view could not be held to apply, a municipality which propped them up by giving them lodgings at less than the market rate was supporting the employer in lowering the minimum wage, and was aiding in the undesirable object of attracting more and more unskilled labour, and hopeless, helpless people into the towns. These, then, were the general arguments against municipal building on a large scale, or, as one might say, "on principle." There remained the special circumstances in which a Corporation like Glasgow was justified in building municipal dwelling-houses or lodging-houses. The first case was that in which the Corporation, in order to benefit the city as a whole, was pulling down insanitary or crowded areas, and dispossessing working people of their homes; and the second case was that in which, in order to fulfil modern hygienic requirements, a kind of house was being made necessary by municipal regulations, which could not be let at the old and cheaper rents. The chief thing that a municipality had now to do was to see that the old problems of insanitary and overcrowded houses, which its own inaction had allowed to come into existence, should not recur.

Section G.—Engineering.—Discovery and Invention.

The Hon. Charles Parsons, D.Sc., F.R.S., fourth son of the third Earl of Rosse. Educated—Private Tuition, St. John's College, Cambridge. Scholar, 1873. Eleventh Wrangler, 1876. Elected F.R.S., 1898. Rowed in L.M.B.C. 1st Boat and

Photo. by Elliott & Fry.]
THE HON. CHARLES PARSONS.

won the College Pairs, 1876. Is proprietor of the engineering works, C. A. Parsons and Co., and Managing Director of the Parsons Marine Steam Turbine Company. He has developed the steam turbine and made it suitable for the generation of electricity and the propulsion of war and mercantile vessels.

In addressing the Engineering Section on the subject of "Invention," the Hon. Charles Parsons considered the subject in its evolutionary aspect, not as a phenomenon suddenly arising out of some happy stroke of fortune, but as the consummation of the successive labours of a number of workers. From this point of view invention was discovery *plus* development. Generally what was usually called an invention was the work of many individuals, each one adding something to the work of his predecessors, each one suggesting something to overcome some difficulty, trying many things, testing them when possible, rejecting the failures, retaining the best, and by a process of gradual selection arriving at the best method of accomplishing the end in view. For example, the first true internal-combustion engine was the cannon. In 1680 Huggens, and ten years later Papin, tried to use gunpowder as a means of obtaining power by exploding it in a large vessel with escape valves. That was a mistake due to ignorance of thermo-dynamic laws, which would have taught them that the best results would be obtained by exploding under pressure. A century later Street tried to use the vapour of turpentine as an explosive mixture, but his machine failed from bad construction, and Brown, a generation after that, tried Huggens' residual vacuum method and failed. Then came Wright in 1833 with a good gas engine, Barnett—who improved on this design—Bansanti, and Matencci each adding something or subtracting something, till Lenoir in 1860 made the first real and practicable engine. From the consideration of the invention the President passed on to the inventor, his difficulties and the obstacles placed in his way by patent laws, and the small reward for his services compared with the benefits he conferred on his fellows. In the course of his address, the President mentioned two inventions, the undertaking of which would be of great service to mankind, but the practical rewards of which to the individual inventor were so small and so difficult to secure adequately to him that they could hardly be undertaken by private effort. One was the problem of aerial navigation, which could only be successfully solved by an organised and adequately trained body of engineers, and the expenditure of a large sum of money. The other was the exploration of the lower depths of the earth—the deepest borings or shafts in which were at present little more than a mile. The President described a hypothetical method of sinking a shaft to great depths, and offered an interesting estimate of the cost. For £500,000 a shaft two miles in depth could be sunk in ten years; for £1,100,000 a shaft of four miles could be sunk in twenty-five years; and so on. A shaft twelve miles in depth could be sunk in 85 years, and would cost £5,000,000. The temperature of the rock at that depth would be, he estimated, 272 degrees Centigrade.

Section H.—Anthropology.—The Pitt Rivers Collection.

MR. HENRY BALFOUR, M.A., was born in 1863. Educated at Charterhouse School. Entered Oxford University in 1881 as a commoner of Trinity College. After taking degree in the Honour School of Comparative Anatomy, acted under Professor H. N. Moseley as Assistant Curator of the Pitt Rivers Ethnological Collection (presented to the University in 1884). After Professor Moseley's death, became Curator of the Pitt Rivers Museum, which had developed considerably. Elected a member of the Council of the Anthropological Institute of Great Britain in 1891, and its President in 1903 and again in 1904. Elected in 1903 to a Research Fellowship at Exeter College, Oxford. Corresponding member of the Anthropological Societies of Paris, Rome and Florence. President of the Oxford Fencing Club.

The address of Mr. Henry Balfour to the Anthropological Section was in the main a description of the ethnographical collection of Colonel Lane Fox, which is better known as the Pitt Rivers collection, from the name which Colonel Lane Fox took in 1880. The President's avowed object in considering this subject was first to bear witness to the very great importance of General Pitt Rivers' contribution to the scientific study of mankind in general; and to defend the system of arrangement which has been adopted in respect of his ethnographical collection. Its collector based his first inquiries on the theory that the weapons which man used were

Photo. by Hills & Saunders.]

HENRY BALFOUR.

built up by a process of evolution; and he was led to believe that the same principles must probably govern the development of the other arts, appliances, and ideas of mankind. On this belief and principle his collection was formed.

Section I.—Physiology.—Correlation of Nerve-Arcs.

PROFESSOR SHERRINGTON, M.D. and D.Sc., Cambridge; LL.D. Toronto; made Fellow of Royal Society in 1893; and Honorary Member of the Academy of Medicine in Vienna. Has been given the Marshall Hall Prize and the Baily Medal. His chief work has been on the nervous system. Eight years Lecturer on Physiology at St. Thomas's Hospital, London, and four years Professor Superintendent of the Brown Institute, London.

Professor C. S. Sherrington began his address to the Physiological Section with a definition of the points of view from which physiology studies the nervous system. They were three. One of them regarded its processes of nutrition. Such processes could be followed in the nerve cell, as in other cells. But the cells of the nervous system had certain functions which were specialised; and one of these was the power of the nervous cell to transmit states of excitement—a power which was called conductivity. The examination of this property was the second problem. The third was the investigation of the way in which by this conductivity the separate cells and units of an animal body were welded into a single whole, and how from a mere collection of organs there was made a single animal. It was one of the general problems of this third branch of inquiry to which Professor Sherrington invited the attention of his hearers; and the problem was concerned with the chain of conduction, and with the ways in which the nerve arcs, from a sense organ to a limb muscle, for example, are connected.

Photo. by Sayce & Steinman.
PROF. C. S. SHERRINGTON.

Section K.—Botany. The Preception of the Force of Gravity by Plants.

MR. FRANCIS DARWIN, F.R.S., President of the Botanical Section, is the third son of Charles Darwin and of Emma Wedgwood, and was born 1848, at Down. (The Editors of "KNOWLEDGE AND SCIENTIFIC NEWS" asked Mr. Darwin if he would be kind enough to oblige them with some biographical particulars, and those that he has furnished are so interesting that it is thought desirable to leave them in their present form.) Mr. Darwin writes: "I was educated at Trinity College, Cambridge (M.A., M.B.), and St. George's Hospital, London. When a medical student I worked at the Brown Institute under Dr. E. Klein, and this was my first real bit of education in science. Dr. Klein gave me some original work to do, part of which served as my thesis for the Cambridge M.B. Dr. Klein's influence made me desire to take up natural science rather than the practice of medicine, so that I was only too glad to accept my father's proposition, that I should act as his assistant. I lived at Down, working with my father till his death in 1882. I then moved to Cambridge where I ultimately became Reader in Botany and Fellow of Christ's, my father's old college.

"My scientific work has been in Physiological Botany, on which I have published various papers. My 'Practical Physiology of Plants' (1894) (for which the late E. H. Acton wrote the chemical part) has had some influence on the teaching of this part of botany, and is now in its 3rd edition. I also wrote a little book, 'The Elements of Botany' (1895), which gives the substance of my lectures to medical students.

"In 1887 I brought out 'The Life and Letters of Charles Darwin.' In 1892 an abbreviated version in one volume was published, giving the autobiography, my personal recollections, and a selection of the letters.

"In 1903, in collaboration with Mr. Seward, I brought out 'More Letters of Charles Darwin,' two volumes made up chiefly of letters which could not be included in the 'Life,' but also containing material obtained since 1887. During the present summer I shall resign the Readership of Botany and my Fellowship, and propose to live in London.

"Through the kindness of the Committee of the Chelsea Physic Garden, I am for the present provided with a laboratory, and with house room for my father's library, which I have been permitted to deposit in the lecture-room at the Physic Garden."

Mr. Francis Darwin's address to the Botanical Section was a summary of the knowledge that has been gained of the ways in which plants become sensible of the influence of gravity, and adjust themselves to its suggestions. As long ago as 1824 Dutrochet imagined that the movements of plants were dictated at the suggestion of changes in their surroundings rather than that they were the direct and necessary

Photo. by Elliott & Fry.
FRANCIS DARWIN.

result of such changes. Mr. Darwin has been in the habit of expressing the same thing in other words, using the idea of a guide or sign-posts, by the perception of which plants were able to make their way successfully through the difficulties of their surroundings. The force of gravity was one of the most striking features of a plant's environment; and in the sensitiveness of a plant to this force we had one of the most widespread instances of a plant's ability to read a sign-post and direct its growth accordingly. Mr. Darwin's paper reviewed the ways in which what might be called the sense-organs of plants transmit the knowledge throughout its organism, and the ways by which in theory these sense organs are affected by the outside influence.

Sub-Section.—Agriculture.

DR. WILLIAM SOMERVILLE, M.A., D.Sc., owned and farmed a small estate in Lanarkshire till 24. From 24 to 28 studied agricultural science in Edinburgh University during winter, and travelled on the Continent during summer. Secured Vans Dunlop Scholarship and went to Munich in 1888 to study forestry. Appointed Lecturer on Forestry, Edinburgh University, 1889. Professor of Agriculture and Forestry, Durham College of Science, 1891. Professor of Agriculture, Cambridge, and Professorial Fellow of King's College, 1899. Assistant Secretary to the Board of Agriculture, with charge of the Branches of Intelligence and Education, 1902. Started experi-

mental farms in Northumberland and Cambridge. Chiefly identified with experimental work on finger, and, toe in turnips, and with the influence of manures on the feeding properties of pasture. Graduate of Edinburgh, Munich, Durham, and Cambridge. Has served on Departmental Committees on Forestry, Sheep Parasites, and Fruit. Written a good deal on agricultural and forestal matters.

Dr. William Somerville, the President of the new Sub-Section of Agriculture, took for his subject "Recent Work in Agricultural Science": and dealt successively with the latest experiments at Rothamsted: German work on the storage of farmyard manure, forestry, the Woburn Fruit Station, and the improvements in the scientific variation of crops. Dr. Somervelle also devoted some paragraphs to that fixation by electricity of atmospheric nitrogen, which, as Sir William Crookes hoped, might some day provide us with artificial nitrates and cheaper manures and soil stimulants. This work was going on well, said the President, and he believed agriculture would not have long to wait before it was placed in possession of "that most powerful agent of production." The President also reviewed the partial failure of the attempt to supply artificially the bacterial organisms which are naturally found at the nodules of leguminous plants, and so stimulate their growth. These bacterial cultures—"nitragin," as the experimental samples were called—had been a failure of late when applied on a large scale; but both in Germany and the United States, where faith and belief in the value of "nitragin" was considerable, the experiments were being vigorously pursued with what was called "improved nitragin."

Photo. by Moffat.]
DR. WILLIAM SOMERVILLE.

Section L.—Educational Science.

THE RT. REV. JOHN PERCIVAL, D.D., Bishop of Hereford. Born 1834, son of William Percival, Brough, Sowerby, Westmoreland, and Jane, daughter of William Longmire, Bolton, Westmoreland. Married first, 1862, Louisa, daughter of James Holland (died 1896), and second, 1899, Mary Georgina, daughter of the late Frederick Symonds, F.C.S., Oxford. Educated at the Grammar School, Appleby, Westmoreland, and Queen's College, Oxford, of which he was a Scholar. Junior Mathematical University Scholar 1855. Double First Mods and Finals; M.A., 1861. Fellow of Queen's College, Oxford. Ordained, 1860. Assistant Master Rugby. Headmaster Clifton College, 1862-1878. Prebendary of Exeter, 1871-82. Canon of Bristol, 1882-7. President Trinity College, Oxford, 1878-87. Headmaster Rugby, 1887-1895. Bishop of Hereford since 1895.

The Presidential address to the Educational Section was an attempt to define the limits of investigation which science might usefully set itself in dealing with education. In the consideration of these limits it was necessary to give due regard to right ideals of moral and social progress as a primary part of the whole; and it was necessary to decide what methods of investigation were appropriate and what were inappropriate to the duty of education. The Bishop of Hereford went on to criticise the various defects in the national outlook on education; and in the various systems of primary, secondary, and public school education; and he laid down the general principle that one of the things needed for the general improvement of our secondary education was that every private school, of whatever kind, should be liable to public inspection and public report thereon; that a licence should be required for every such school: and that the staff and their qualifications, and the remuneration given to each of them, the sanitary condition, suitability and educational equipment of the premises, should all be considered in connection with the giving or withholding of a licence.

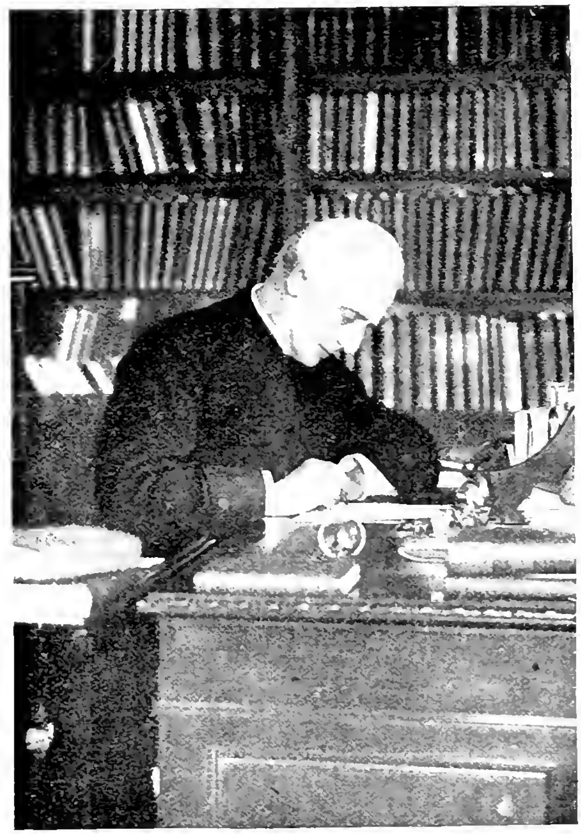


Photo. by W. H. Bustin.]
THE RIGHT REV. THE LORD BISHOP OF HEREFORD.

THE FOREIGN GUESTS.

UPWARDS of 200 American, Canadian, and foreign men of science attended the Cambridge gathering of the Association. We append a few details respecting the scientific achievements of some of the more familiar names, limitations of space forbidding extended reference.

American and Canadian.—PROFESSOR W. O. ATWATER, who lectured in the physiological section on "Nutrition Experiments on Man in the United States," has occupied the chair of Chemistry in the Wesleyan University, Middletown, since 1873. On the establishment of the Connecticut Agricultural

Experiment Station—the first of its kind in the United States—he became Director, and engaged in the important nutrition investigations promoted by Congress in connection with the Experiment Stations of the United States Agricultural Department. The Carnegie Institution has granted £1000 in furtherance of this work, and £1300 to Dr. Arthur Gamgee, F.R.S., of Montreux, for the preparation of a report upon the results so far attained. Professor Atwater has published numerous papers in physiology.

Prof. W. B. Scott, of Princeton University, New Jersey, is best known for his labours in the elucidation of the fauna of Santa Cruz: also for investigations connected with the Princeton Expedition to Patagonia. The results of the latter will be completed during the next few years in eight volumes, somewhat after the model of the "Challenger" series of zoological reports. Mr. J. Pierpont Morgan has given a subsidy towards the issue. The first instalment, under the editorship of Professor Scott, bears ample testimony to the importance of the researches, while being highly creditable to American zoological workers.

Prof. A. B. Macallum, who holds the Chair of Physiology in the University of Toronto, is well-known for his researches in histology and physiology; and is a teacher of repute. He took a prominent part in the founding of the Canadian Marine Biological Station at St. Andrews, North Brunswick, as well as that at Canso, Nova Scotia. He is the author of many papers, including, "On the Distribution of Iron in Animal and Plant Cells" (Brit. Assoc. 1897); and "On the Localisation of Potassium in Animal and Plant Cells" (Brit. Assoc. 1903).

Prof. A. Lawrence Rotch, a distinguished meteorologist, is Director of the Blue Hill Observatory, U.S.A., librarian of the American Academy of Sciences, and a Chevalier of the Legion of Honour. His observatory was established in 1885, and from thence have been issued from time to time the results of novel investigations of the upper air. He was the first to obtain accurate meteorological records over the Atlantic by means of cloud observations and self-recording instruments lifted by kites.

Prof. John Dewey is Director of the School of Education and Professor of Philosophy in the University of Chicago. He held formerly similar positions in the Universities of Michigan and Minnesota. Professor Dewey is an authority upon the psychology of numbers, and author of a work on the Theory of Ethics.

Prof. R. W. Wood, of the Physical Department of the University of Wisconsin, who belongs to the younger school of American physicists, is well known in English scientific circles. In 1900, he read a paper at the Royal Society on the "Photography of Sound Waves," and at the Society of Arts on the "Diffraction Process of Colour Photography." He is possessed of striking experimental originality, which gives him such a mastery over simple forms of apparatus as to make those accustomed to work only through the medium of more elaborate means somewhat envious of his laboratory and teaching methods. On the occasion of one of his summer visits to San Francisco, struck with the beautiful miniature mirages to be seen during sunlight on certain of the flagstoned sidewalks, he set himself with success to secure a photograph of the phenomenon. At the recent meeting Professor Wood contributed a paper on "Colour Photography."

Prof. Ramsay Wright, Vice-President of Toronto University, is also Curator of the Biological Museum and Professor of Biology in the University. His writings upon the comparative anatomy of vertebrates are numerous. He has prepared a special report upon the Fish and Fisheries of Ontario.

Foreign.—M. Yves Guyot was formerly Minister of Public Works in Paris. The publications of the Cobden Club, of which he is an honorary member, have made his writings on economic subjects, and particularly on the tenets of Free Trade, familiar in this country. M. Guyot was recently the recipient of the "Guy" Medal of the Royal Statistical Society for his paper, "The Sugar Industry on the Continent."

Dr. Josef Korosi, Director of the Bureau of Municipal Statistics at Budapest, is a distinguished member of the Hungarian Academy of Sciences. Under his supervision valuable reports are issued from time to time dealing with mortality and other branches of the science of Demography or Vital Statistics. A voluminous paper on "Natality" was communicated personally by him to the Royal Society in 1894, and afterwards published in the *Philosophical Transactions*.

Dr. Paul Groth is Professor of Mineralogy and Crystallography in the University of Munich, and Keeper of the Collection of Minerals. His studies have earned for him a European reputation. In 1877 he established the *Zeitschrift fur Krystallographie und Mineralogie*, and in 1902, to mark the 25th year of issue of the journal under his editorship, an English Committee of Mineralogists, Geologists, and others presented the Professor with his portrait, painted by Grutzner, of Munich. On the occasion of his visit here, the University of Cambridge conferred on him the degree of Doctor of Science.

Dr. A. Sommerfeld is Professor of Mechanics in the Royal Technical School, Aachen, Prussia. In a paper on the "Scientific Results and Aims of Modern Applied Mechanics," lately published, he has emphasised the desirability of a more practical application of the principles of mechanics from the teaching standpoint.

Prof. Oscar Montelius of the State Museum of History and of Numismatics, Stockholm, is eminent for his researches upon the ancient civilisation and antiquities of Sweden and other Scandinavian countries. It may be mentioned that the subject of his contribution at Cambridge—namely, the evolution of the lotus-ornament—had already received attention at the hands of Mr. W. H. Goodyear in the *American Journal of Archæology*, 1891, in his paper, "The Grammar of the Lotus." The results of Professor Montelius' study will be awaited with interest.

M. Henri Becquerel, Professor of Physics in the École Polytechnique, Paris, has a world-wide reputation on account of his epoch-making experiments with the mineral uranium, whence has sprung the new knowledge, "radio-activity." In 1896 he discovered that salts of uranium emitted a radiation which was capable of affecting a photographic plate after traversing thin metallic screens; also that the rays possessed the power of making gas through which they passed a conductor of electricity. Many will recall Professor J. J. Thomson's evening lecture at the British Association meeting of 1902, "Becquerel Rays and Radio-Activity." Professor Becquerel comes of a line of distinguished physicists. His grandfather and father were both Foreign Members of the Royal Society, the former a Copley Medallist of that body; while the Professor himself has received its Rumford Medal. He was awarded the great Physics prize of the Nobel Institute last year, conjointly with M. and Mme. Curie.

Dr. Erich von Drygalski, Professor of Geography in the University of Berlin, was Scientific Director of the recent German Antarctic Expedition in the *Gauss*, which sailed early in 1902, and returned last year after accomplishing much successful work. Dr. von Drygalski read a paper dealing with the results of the Expedition before the Geographical Section of the Association.

Dr. R. Livy, of the Italian Ministry of War, Rome, is a distinguished anthropologist. His attendance at Cambridge was specially sought in order that his experience in methods of anthropometry might be available in discussions in Section H. on the advantage of a British anthropometric survey. Dr. Livy has recently embodied the results of anthropometric investigations among the troops of the Italian Army in the work, "Anthropometric Militaires."

Comparative Legislation.—Included in the second part of Vol. V. of the "Journal of Comparative Legislation" (John Murray) are articles on English and Continental military codes, by J. E. R. Stephens; "Obeah" in Jamaica, by S. Leslie Thornton; International Railway Transport, by G. C. Pnillimore; and contributions concerning the Antwerp Conference, by Mr. Justice Kennedy and T. G. Cower, K.C.; and on a Council of the Empire by the Hon. W. P. Reeves and Professor T. E. Holland, K.C. Sir John Macdonell writes on Contracts for Labour, and the late Sir William Rattigan on the great jurist Bartolus. The volume is prefaced by a portrait and a biographical notice of the Rt. Hon. R. B. Haldane.

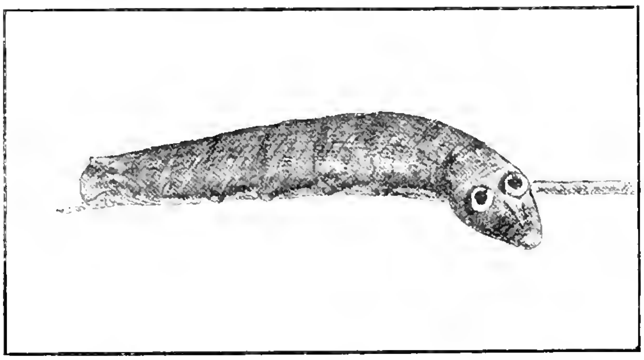
Terrifying Masks and Warning Liveries.

By PERCY COLLINS.

IT has been suggested—and the theory has received, to some extent, the support of experimental proof—that certain kinds of insects derive protection from the grotesqueness or hideousness of their appearance. An oft-cited example is the very remarkable-looking caterpillar of *Stauropus fagi*, the lobster moth. This insect was at one time considered a great rarity in England, and as such was much prized by collectors. Of recent years, however, it has been found in considerable numbers in the beech woods of the Upper Thames valley, and entomologists have had ample opportunity to examine its appearance and habits in the wild state.

Professor Poulton describes the resting caterpillar as possessing a considerable resemblance to a withered leaf irregularly curled up—the likeness being gained by the combined effect of the creature's colour, its curiously modified legs, and the manner in which these are arranged.

It is clear, therefore, that this remarkable larva is concealed from its enemies by a protective likeness to its habitual surroundings. But it has yet another means of defence at its disposal. Should it be disturbed by a rustling of the leaves and twigs in its immediate neighbourhood, and become convinced that its disguise has been penetrated, it immediately assumes what has been called its "terrifying attitude."

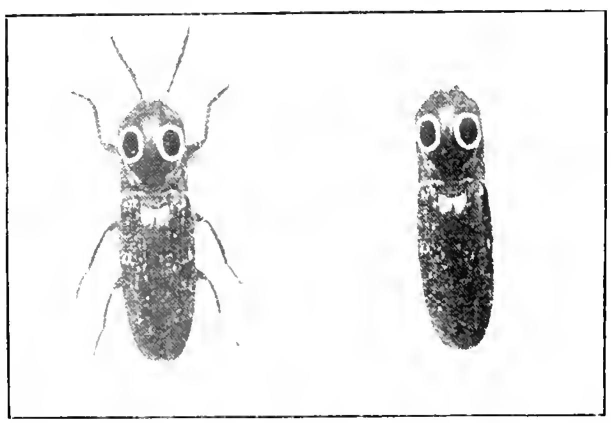


Larva of *Chaerocampa Porcellus*, in terrifying attitude (drawn from life).

In this position it is described as looking very like a large spider, but with all the characteristic points in a spider's appearance greatly exaggerated for the sake of effect. The legs and body are, for the time being, arranged in such a manner that the creature seems changed from a harmless caterpillar into something strangely disquieting to look upon.

In thus mimicking the attitude and appearance of an exaggerated spider, the lobster moth caterpillar is really trading upon the reputation of a well-recognised noxious creature; and the defence has been shown by experiment to be of no little avail against the attacks of birds and other insect-eating creatures, which exhibit varying degrees of alarm and disgust at sight of the caterpillar in its terrifying attitude. But, as several observers have pointed out, it is more than likely that the spider-like appearance exists mainly as a special safeguard against the insect enemies of *Stauropus fagi*. In common with the larvæ of most Lepidopterous insects, this caterpillar is liable to the attacks of ichneumon flies, which deposit their eggs upon or beneath its skin. In the majority of instances such "stung" larvæ die miserably ere they are able to assume the imago state; and it is only reasonable to assume that any trick or device calculated to scare away these insect foes would directly benefit the species by enabling a greater number of its caterpillars to arrive at maturity. And as a large and presumably ferocious spider is a vision of dread to all the lesser denizens of the insect world, the lobster moth caterpillar's terrifying mask is probably very effective.

Larva of *Chaerocampa Elpenor*, showing "eye spots" on fourth and fifth segments of body.

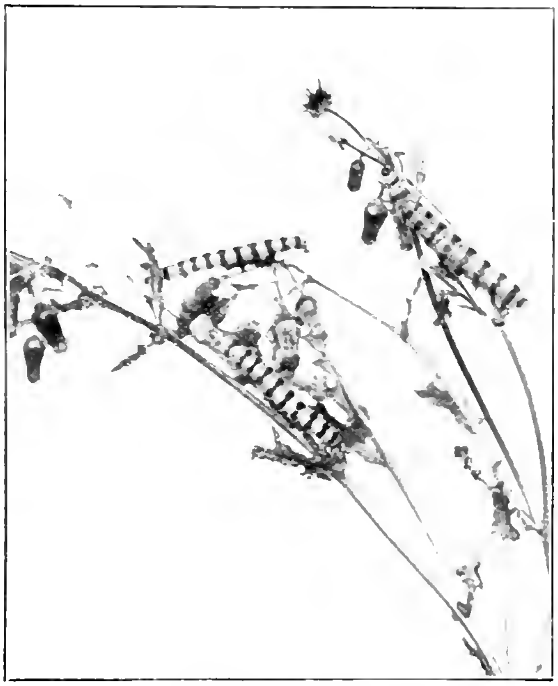


***Alaus sp.* Central America. As it appears when running; and when, under the stimulus of alarm, it has drawn its legs and antennæ beneath its body.**

Similar instances of what looks like trading upon the reputation of some well-known noxious creature occur among insects, and in some instances the prototype seems to belong to some widely different group of living creatures. Thus, a South American caterpillar mentioned by Mr. Bates startled everyone to whom it was shown

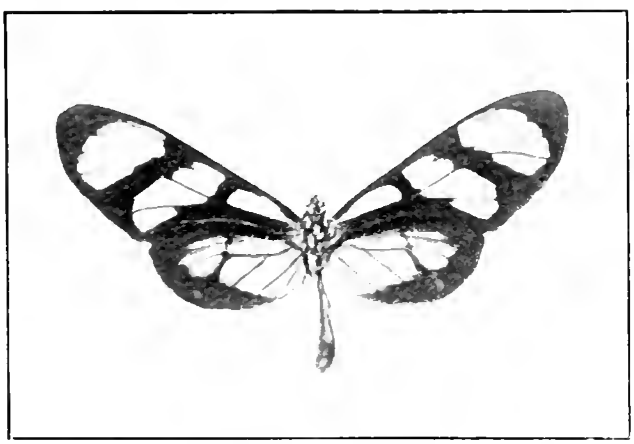
by its snake-like appearance: while among our native species the larvæ of the two elephant hawk moths (*Chærocampa elpenor* and *C. porcellus*) are striking instances of a protection gained in a similar manner.

Like the caterpillars of the lobster moth, those of the elephant hawks are difficult to detect when they are at



Larvæ of *Euchelia jacobææ.*

home among the leaves of their food plants, owing to their brown—or more rarely green—colouring. But when actually discovered, or when thoroughly alarmed by the rustling of the leaves, the caterpillar draws back its head and the first three segments of its body into the fourth and fifth segments. What then happens is well

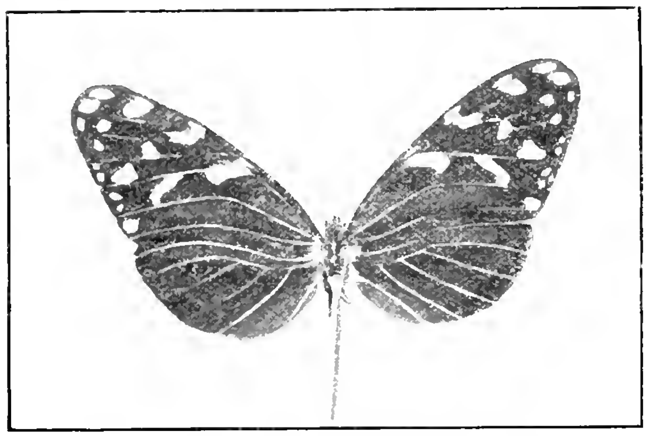


Methona themisto. Ex Rio Granda (black, with "clear" areas).

described by Professor Poulton. "These two rings (the fourth and fifth segments) are thus swollen, and look like the head of an animal upon which four enormous, terrible-looking eyes are prominent. The effect is greatly heightened by the suddenness of the transformation, which endows an innocent-looking animal with a terrifying and serpent-like appearance."

This description applies to the *C. elpenor*. In the case of *C. porcellus* the eye spots on the fifth segment, though present, are comparatively inconspicuous. It is a curious fact that these strange markings do not attract particular attention when the caterpillars are quietly at rest or feeding. As soon, however, as they assume their terrifying mask, under the stimulus of apprehended danger, the staring "eyes"—owing to the swelling of the segments as the head and first three body rings are withdrawn—become enormous and prominent. All field entomologists who are familiar with these caterpillars in the wild state are willing to bear testimony to their startling appearance when they have assumed their terrifying attitude.

Very similar eye spots, probably of a like protective value, are seen upon the thoraces of certain Central American beetles of the genus *Alaus*. As in this case the markings are delineated upon the hard surface of the thorax they are not really more marked at one time than another. Yet their terrifying appearance is enhanced considerably when the beetle assumes the attitude with which it responds to indications of approaching danger. In common with most species of the great "click-beetle" group (*Elateridæ*) to which the genus *Alaus* belongs, these insects are capable of folding their legs and antennæ so



Melinea mesatis. Ex Columbia S.A. (red, brown; anterior areas of fore-wings black, spotted white).

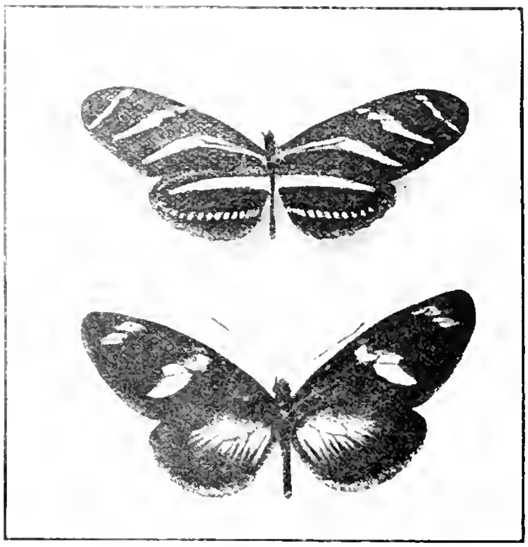
closely beneath the body that they are completely hidden, and of remaining perfectly quiescent in this attitude for a long period of time. A glance at the accompanying photograph will give the reader some idea of the weird appearance of an *Alaus* beetle under these conditions. It cannot be said to resemble any other living creature, noxious or innoxious. Yet its appearance is sufficiently forbidding to discourage hostile attack.

In dealing with the first part of our title we have briefly discussed several insects which are able, at will, to masquerade as something terrible and alarming. They can put on, as it were, terrifying masks, and scare away their would-be persecutors. But the protection thus gained is the outcome of bare-faced bluff, and it is conceivable that the enemy may one day discover and profit by this fact. Warning liveries, on the other hand, are anything but meaningless bluster. They indicate that the creatures distinguished by them possess certain noxious characteristics which render them unwholesome or unpalatable.

At the present day, students of entomology accord a fairly general acceptance of the theory of warning coloration as explaining certain extremely striking colours and colour contrasts which occur throughout the insect world. In cases of protective colouring, the

insects resemble more or less closely those objects by which they are habitually surrounded—the protection becoming more certain in proportion to the completeness of the likeness. But with warning colours, exactly the reverse is the case. Insects assignable to this class are not coloured to be hidden, but in order that they may readily be seen.

It is believed—and in many instances this is definitely known to be the case—that such conspicuously coloured insects possess some hurtful quality which renders them inedible, and that their showy livery acts as a warning to insectivorous creatures in general. The reason why warning colours are thought to benefit a species is explained in the following manner. Insects are, for the most part, very frail creatures, and one peck from a bird bent upon testing the edibility of (say) a caterpillar, would, in all probability, result in the creature's death. Thus, the mere fact of its being unsuitable for food would be of no avail in saving its life. But if the cater-



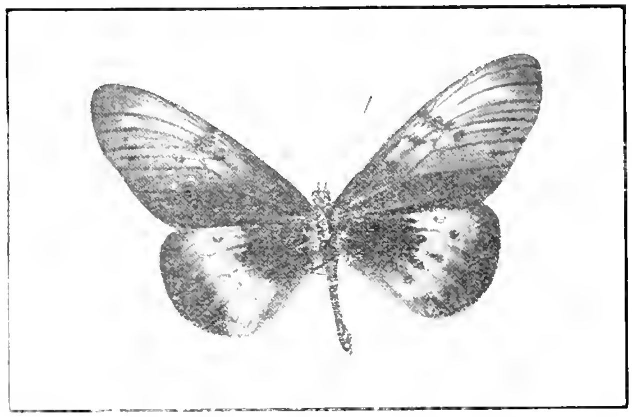
1—*Heliconia charithonia.* 2—*Heliconia quirina.* **Ex Trop. South America. The Heliconiidæ have all dark brown or black wings, lined or spotted with very brilliant colours.**

pillar were coloured in a manner sufficiently striking to become impressed upon the mind of the bird, a distinct advantage to the species might be expected to result. For the bird, presuming it to be capable of learning a lesson, would give up "experimental tasting" in so far as insects coloured in a similar manner were concerned.

As an example of a warning colour combination by no means uncommon in the insect world, the caterpillar of the Cinabar moth (*Euchelia jacobææ*) which is zebra striped in alternate bands of black and yellow, may be cited. This larva has been proved to be nauseous in taste, and to be rarely eaten by birds or other insectivorous creatures old enough to have gained experience in "the ways of the world." The same yellow and black striping is to be seen upon the bodies of many species of wasps and bees—insects which would prove very unsatisfactory eating on account of their poisonous stings.

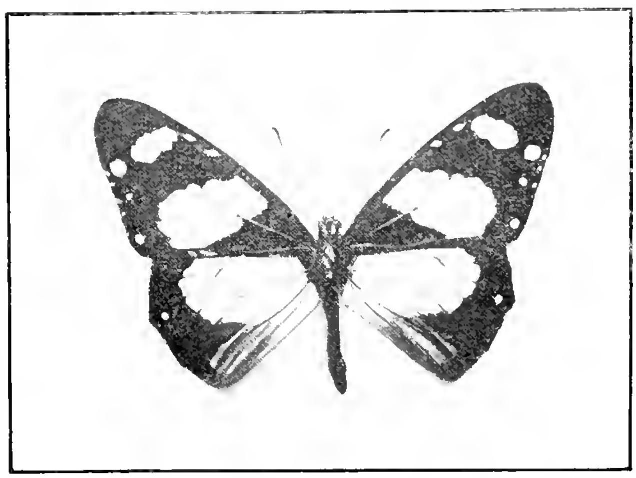
The theory of warning coloration was first suggested by Dr. A. R. Wallace to account for the extremely bright colours exhibited by certain caterpillars. It has since been applied to whole tribes of insects, of all orders; and so strong is the evidence in its favour—the result of systematic experiments conducted in various latitudes with birds, lizards, and other insect-eating creatures—that what was originally a theory may now fairly be regarded as a well-established fact. Indeed, so distinct are the colours and colour combinations possessed by inedible species, and so unlike are they to the colours of insects which do not possess noxious qualities, that the student is frequently able to tell at a glance whether a given species is an example of warning coloration or not, even though he may never before have seen it.

Amongst butterflies, the examples of warning liveries are particularly striking.



Acraea sp. **Ex Sierra Leone (fore wings sooty, black spots; hind wings brick red, black spots.)**

In South America, the "protected" species—as those which possess some noxious quality are usually termed—are exceedingly numerous, and are well typified by such genera as *Methoma*, *Melinea*, and *Heliconius*. These butterflies are rendered inedible by the acrid or evil-smelling juices contained in their bodies. Even in the case of long-dead specimens which have been temporarily



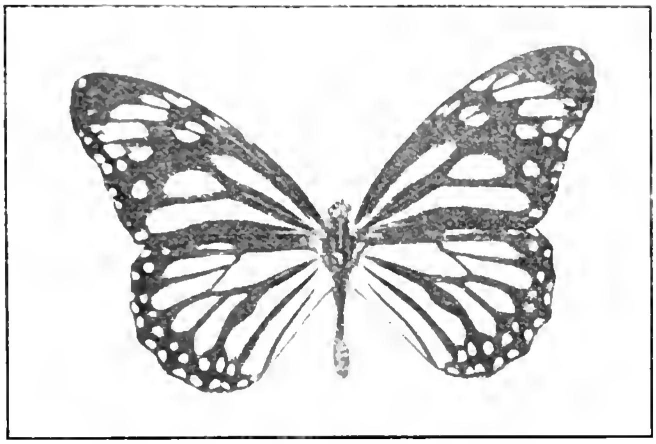
Amauris ochlea. **Ex South Africa (blackish-brown, with white areas).**

relaxed for setting, the unpleasant odour of these juices is very apparent, resembling the scent which is left upon the fingers after handling a ladybird beetle. Such butterflies, in common with other evil-tasting species in other parts of the world, are slow and measured in their flight, fluttering in an unconcerned manner from flower to flower as though experience had taught them that they have little to fear from birds, reptiles, monkeys and other enemies to insect life.

Although the species of warningly coloured butterflies are exceedingly numerous in the New World, they are

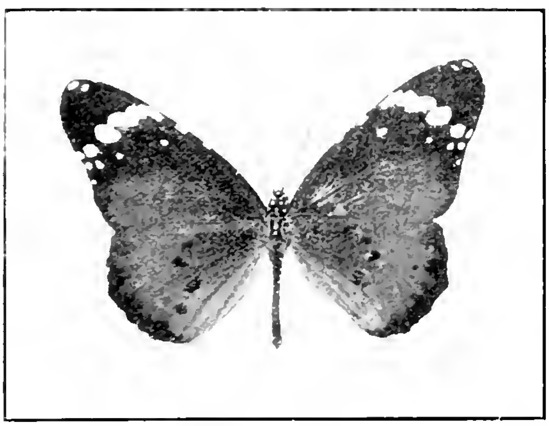
by no means unrepresented in other parts of the globe. In Africa, the genera *Acraea* and *Amauris* have a wide range, and are represented by many well-marked species. While in the Indo-Malayan region the great sub-family of the *Danainae*, all the members of which are rendered conspicuous by their warning liveries, is a dominant group.

The accompanying photographs represent a few common and very typical warningly coloured butter-



Danais Elmondi. **Ex Philippines (white and black).**

flies, and a glance at them will give the reader a better idea of the special designs associated with inedibility than could be gained from a mere description. It will be seen that the aim is to produce a startling effect; one, moreover, that will not easily be overlooked or confused. On contrasting such warning liveries with the tints of insects which are wholly or partially protectively coloured to harmonise with their surroundings, it becomes very obvious that designs so different must have been pro-



Danais Chrysippus. **Widely distributed in Eastern Hemisphere fulvous-brown, marked with black and white.**

duced in response to equally diverse circumstances. It is, moreover, worthy of note that warningly coloured butterflies, as a rule, differ little in the tinting of the upper and under surfaces of their wings; whereas butterflies unprotected by inedible qualities, even though they may possess brightly coloured upper surfaces to their wings, usually have them tinted beneath in harmony with leaves, bark, sand or rock. Thus, as soon as they settle with folded wings, their protective colouring comes into play.

Modern Cosmogonies.

By Miss Agnes Clerke.

X.—The Forms of Nebulae.

Sir William Herschel's celestial surveys first made the classification of nebulæ practicable. Until he began grinding specula at Bath very few such objects were known, and those too imperfectly for the effectual discrimination of their differences. Arrangement presupposes comparison, and comparison some variety of specimens to be compared, which became available only through Herschel's scrutiny. The rapidity and penetrative power of his observations in this field almost passes belief. He detected with discernment. Discovery and enrolment did not satisfy him; he was, besides, keen to note analogies and contrasts, likenesses and dissimilitudes. He could not see without at the same time setting in order what he saw; and the law of order that commended itself to him was founded on an evolutionary principle. The contents of the heavens seemed to fall spontaneously, as he regarded them, into genetic sequences; and the nebulæ with particular facility. The criterion adopted was that of progressive condensation. Development must clearly, he judged, be attended by contraction and local brightening. Diffused milky tracts represented cosmic formations in their most rudimentary form; they assumed, through the unremitting action of gravity in drawing their particles together, a more compact texture, more definite shapes, and a heightened lustre.

But things have changed somewhat in aspect during the last hundred years. Herschel's simple rule of arrangement, although of unquestioned validity, needs to be supplemented by others. Much auxiliary knowledge has been acquired since it was formulated. In attempting to estimate the comparative antiquity of nebulæ, we no longer depend exclusively upon one set of indications. The conclusions drawn from their immediate inspection can at least be checked by the study of their spectra and distribution.

The Milky Way might be figuratively described as the nursery-garden from which the parterres of the universe are stocked. A primitive condition is usually assigned, not without good reason, to any class of objects markedly tending to collect in its plane. And this is the case with gaseous, or "green" nebulæ. Moreover, their materials appear to be in a highly elementary state (if it be permissible to speak of one kind of matter as more elementary than another); their spectra including no rays due to metallic incandescence, but mainly those of nebulium, hydrogen, and helium. These substances, inconceivably attenuated, constitute the vast irregular formations placed by Herschel at, or near, the start of cosmical development. And so far he has been justified by the outcome of modern research. But he has not been justified in his description of planetary nebulæ as "very aged, and drawing on towards a period of change or dissolution." For, despite their determinate shape and definite boundaries, they do not appreciably differ in composition from nebulæ of the "irregular" class, and must be reckoned as, in a manner, coeval with them.

There is, on the whole, a concurrence of evidence that gaseous nebulæ are at a very early stage of growth. They are the least elaborated of sidereal objects; they seem, many of them, barely to have crossed

the threshold of creation. Their mutual relations in time are, however, by no means obvious. They cannot easily be disposed in any kind of sequence. Each of the great nebulæ, at any rate, exhibits features and occupies a position shared by none of its fellows. The most discerning cosmologist cannot pretend to say that the Argo nebula, for instance, is of greater or less antiquity than the Orion or the "America" nebula. They are individual growths, simultaneous, not successive. The line of development indicated for them is rather towards the formation of star-clusters than of diverse nebular species. Thus the Pleiades may illustrate the probable future condition of the Orion nebula, the contained stars having gained predominance, though still wrapt in filmy swaddling-bands, later, presumably, to be shaken off.

Planetary nebulæ have much more in common than irregular nebulæ, and their minor varieties might, with some plausibility, be associated with differences in relative age. They are marked chiefly by the character of the nuclear star which, in nearly all such objects, appears to act as the pivot of the surrounding vaporous structure. The supposition lies close at hand that it is designed as a provision for the nourishment of the star—that the star gains in mass and light at the expense of the nebula, which it is eventually destined to absorb wholly and supersede. On this view, planetaries like the green glow-lamp at the pole of the ecliptic (N.G.C. 6543) should be regarded as the most advanced, while Webb's planetary in Cygnus (N.G.C. 7027) would exemplify an inchoate condition. In the former the central star is of 9.6 magnitude, and sharply stellar; in the latter it is double and diffuse,* perhaps a wide binary system in embryo.

The question is, however, still open as to the real nature of the connection between planetaries and their central stars. The pabulum-theory is a promising conjecture; but no facts with which we are acquainted stringently enforce it. Ideas on the subject will need complete revision if the traces of spirality noted from time to time in some of these peculiar objects prove to be of radical significance. The *owls*, distinctive of the "Owl nebula" (N.G.C. 3587) as originally shown by the Parsonstown reflector, consisted of luminous traceries coiled round *two* interior stars,† but the appearance was either due to illusion, or became effaced by change, since the camera has refused to endorse it as genuine. The "helical" planetary in Draco,‡ however, is doubtless essentially a spiral conformation§; and Professor Schaeberle, by means of exposures with a thirteen-inch reflector of twenty inches focus, has compelled not only the Ring nebula in Lyra, but the Dumb-bell in Vulpecula to betray the surprising secret of their whorled structure.|| Both these nebulæ give a spectrum of bright lines, and invention is baffled by the problem of building up gaseous materials into strongly characterised edifices. The materials, however, may not be purely gaseous;¶ or we possibly see (as Professor Darwin long ago suggested) merely illuminated stream-lines of motion [illegible] an obscure mass. But if this be indeed so, there is the further question to be asked: What direction does the motion take? Do the tides set inward or outward?

* Keeler, *Lick Publications*, Vol. III., p. [illegible].
† Rosse, *Trans. Roy. Dublin Soc.*, Vol. II., p. [illegible].
‡ First detected as such by Holden and Schaeberle in 1888, *Monthly Notices*, Vol. XLVIII., p. [illegible].
§ Deslandres, *Bull. Astr.*, Feb. 1900.
|| *Astr. Jour.*, Nos. 530, 547.
¶ Maunder, *Knowledge*, Vol. XIX., p. 30.

Our spontaneous impressions are all in favour of concentrative tendencies. We cannot easily shake off centripetal prejudices. Our lives are passed under a regimen of central attraction, and we naturally incline to universalise our experience. Hence Herschel's scheme of sidereal evolution invites at first sight ready acceptance. Stars seem as if they could not act otherwise than as foci of condensation in nebulæ; the lucid stuff involving them must, apparently, with the efflux of ages, settle down towards their surfaces, and become absorbed into their substance. Such processes indeed, apart from counteracting causes, belong to the inevitable order of Nature; but these may, and probably do, exist. From sundry quarters the conviction is pressed upon us that cosmic bodies can drive out matter as well as draw it in. Repulsive forces insist upon recognition, and their effects become more palpable the more attentively they are considered. Under certain conditions they get the better of gravity; and stars may possibly, like cocoon-spinning insects, expend their organic energies in weaving themselves unaccountably educed envelopes. The example of Nova Persei is fresh in every mind, but we make no pretension to decide the controversy it raised. A dogmatic pronouncement is unadvisable where the unknown elements of the question obscure and outweigh those that are known. A less slippery foundation for reasoning is afforded by the permanently visible spiral nebulæ, and features charged with an emphatic meaning have been revealed in them by photographic means.

Looking at the entire contents of the nebular heavens, we find the spiral type very largely predominant. It claims more specimens, and emerges more distinctly with each development of delineative power. Its chief prevalence, however, is among "white" nebulæ, showing continuous spectra.

They are vastly numerous. Gaseous nebulæ are reckoned by the score, white nebulæ by tens of thousands. Moreover, they collect near the poles of the Milky Way,* while the gaseous variety crowd towards its plane, both branches of the family thus manifesting galactic relationships, though of an opposite character. Now these facts of distribution are not without indicative import as to relative age. There is a consensus of opinion that objects showing a marked preference for the Milky Way are at an earlier stage of growth than those withdrawn from it, and the inference derives countenance from the circumstance that nebulæ situated in high galactic latitudes shine with continuous light, those near the galactic equator with interrupted radiance. Yet it would be rash to assume that any individual nebula traverses these successive stages. The series could be satisfactorily established only if we could point to a number of intermediate instances, which seem to be almost wholly lacking. We cannot trace in nebular as we can in stellar growth the insensible gradations of progressive change. They are, perhaps, complicated in nebulæ by influences of a different kind from those which have gained the ascendency in stars. Diffusive effects may in them be more conspicuous than concentrative effects;† or a balance may be temporarily struck between antagonistic tendencies.

Spiral conformation is the real crux of nebular cosmogony. The conditions from which it arises are

* Dr. Max Wolf places the point of nebular concentration in R.A. $12^h\ 53^m$, D. + 61° 20′, that assigned to the galactic pole being in R.A. $12^h\ 40^m$, D. + 62°. *Königstuhl Publ.* Bd. I. p. 174.
† T. J. J. See, "Repulsive Forces in Nature," *Pop. Astr.*, No. 100, Dec. 1902.

met with only in the sidereal heavens, but are there widely prevalent. Though remote from our experience, they are fundamental in the realms of space. If we could define and comprehend them we should be in a better position for determining the cosmical status of nebulae.

The choice is open between two rival theories of nebulous spirals. The first is the more obvious, and readily falls in with admitted mechanical principles. Sir Robert Ball has adopted and ingeniously advocated this view.

A globular collection of promiscuously revolving particles inclines, if left to itself, to flatten down into a disc. The reason is this: In a system of the kind, moment of momentum is invariable, while energy constantly diminishes. To render the contrast intelligible we have only to consider that moment of momentum is the algebraic sum of all the products of mass and motion in the aggregation, reduced to, or projected upon its "principal plane," while energy is independent of the varied directions of velocity. Collisions consequently involve no diminution of moment of momentum, but combine with radiative waste to produce a steady loss of energy. Inevitably, then, the system will assume the form in which it possesses the minimum of energy that is consistent with the maintenance of its original momentum; and it is that of a disc extended in the principal plane. Retrograde movements will by this time have become eliminated; the constituent particles circulate unanimously in one direction; and Sir Robert Ball adds that their circulation, owing to the more rapid rotation of the central mass, is along spiral paths.* They would accordingly present the twisted conformation so commonly observed in the heavens, and might even include subordinate centres of attraction, fitted to ripen and strengthen into a full-blown retinue of planets. Such are spiral nebulae regarded in their direct mechanical aspect. Spherical nebulae are their immediate progenitors; suns, with or without trains of dependent worlds, their lineal descendants.

Let us, however, consult some autographic records and weigh attentively what these peculiar objects tell us about themselves. We see at once that their curving lines are not laid down at hap-hazard, but according to a strictly defined plan. Spiral nebulae are not formed like watch-springs by the windings of a single thread. They are always two-branched. From opposite extremities of an elongated nucleus issue a pair of nebulous arms, which enfold it in double convolutions. Their apparent superposition and interlacements occasion, in the Lyra nebula, the noted effect of a fringed and ruptured annulus, and it is of profound interest to perceive that even in gaseous masses the same constructive rule prevails as in the great Whirlpool in Canes Venatici.

It is, however, almost irreconcilable with the hypothesis that an influx of material is in progress. Falls due to gravity could not be limited to two narrow areas on the central body. Matter ejected from it might, on the other hand, quite conceivably follow this course. Interior strain could easily be supposed to cause yielding along a given diameter, and nowhere else. Solar disturbances partially and dimly illustrate such a mode of action. Diametrically opposite prominences are not unknown. They indicate the action of an explosive force right across the solar globe. Similarly, the formation of a spiral nebula cannot be rightly apprehended otherwise than as the outcome of long-continued, oppositely directed eruptions.

The history of the heavens involves the law of spirality. The scope of its dominion continually widens as research becomes intensified. The Huygenian "portent" in the Sword of Orion now figures as merely the nucleus of the "great winding Nebula" photographed by Professor W. H. Pickering in 1889. That the vast nebulosity encompassing the Pleiades is an analogous structure seems eminently probable, though the brilliancy of the enclosed stellar group obliterates most traces of its ground-plan. The magnitude of the phenomenon, we are told by Professor Barnard who detected it in 1893 by means of a ten-hours' exposure with the Willard lens, transcends our powers of realisation. It covers 100 square degrees of the sky with intricate details. About four minutes of arc to the north-west of the Ring in Lyra lies a small nebula discovered visually by Professor Barnard in 1893, and photographically resolved by Keeler into a delicate spiral. It is a two-branched, left-handed spiral, as the large adjacent object has also proved to be. One is, in fact, the miniature of the other, and they are now shown, by Professor Schaeberle's short-focus reflector, to be linked together by winding folds of nebulosity into a compound spiral system. The Dumb-bell is held, on the same authority, to be similarly conditioned, and the analogy frequently noted in the aspects of these remarkable formations has thus become incalculably widened in scale.

The galactic relations of the Magellanic Clouds are not easily defined. They are within the Milky Way, yet not of it. Enigmatical excrescences upon the universe, they suggest an origin from gigantic eddies in the onflowing current of sidereal arrangement. Their miscellaneous contents are, at any rate, disposed along eddying lines. Mr. H. C. Russell's photographs† rendered this, in 1890, to some extent manifest, and their indications were ratified by the Arequipa plates from the study of which Professor Pickering gained the conviction that the great Looped Nebula, 30 Doradus, is the structural nucleus of the Nubecula Major. "It seems," he wrote,‡ "to be the centre of a great spiral, and to bear the relation to the entire system that the nebula in Orion bears to the great spiral nebula which covers a large part of that constellation."

On all sides, in the sidereal heavens, we can discern the signs of the working of a law of convolution. Sometimes they are patent to view; sometimes half-submerged; but they can generally, with attention, be disentangled from overlaying appearances. They are exhibited by stars no less than by nebulae, as the late Dr. Roberts pointed out from convincing photographic evidence; the "hairy" appendages of globular clusters betray them by their curvilinear forms; they meet us in every corner of the wide nebular realm. Many investigators recognise in the Milky Way itself the stamp of spirality. Stephen Alexander, of New Jersey,§ regarded the majestic galactic arch as a four-branched spiral, resulting from catastrophic breaches in a primitive, equatorially loaded spheroid, the streams of matter ejected by which should, owing to their lower angular rotation, lag behind as they retreated from the nucleus, and thus flow along helicoidal lines. R. A. Proctor subsequently devised convoluted

* *The Earth's Beginning*, pp. 243-7.

* *Monthly Notices*, Vol. LX., p. 250.
† See *Knowledge*, Vol. XIV., p. 50.
‡ *Harvard Annals*, Vol. XXVI., p. 206.
§ *Astr. Jour.*, Vol. II., p. 100, 1852.

galactic streams, which, however, corresponded imperfectly with what the sky showed. And M. Easton has designed an elaborate series of spires, originating possibly from that vague entity, the "solar cluster," the projection of which upon the sphere may, he thinks, account for the noted peculiarities of the Milky Way. Our interior situation, nevertheless, makes it extremely difficult to determine the real relations in space of the star-streams circling around it. The observed facts are, perhaps, equally compatible with many other structural schemes besides those based on the idea of spirality; and the wiser course may be to adopt none, for the present, with settled conviction. We can, however, gather one sufficiently definite piece of information regarding the history of the Cosmos. All the inmates of the heavens, stellar and nebular, represent quite evidently the *débris* of a primitive rotating spheroid. Its equator is still marked by the galactic annulus, its poles by a double canopy of white nebulæ. The gyrating movement which it once possessed as a whole doubtless survives in its parts, but ages must elapse before the fundamental sidereal drift can be elicited.

Astroph. Jour., Vol. XII, p. 158.

Variability in Sociology.—I.

By J. Collier.

To most readers, perhaps, and certainly to all non-biologists, the chapter in *Darwinism* on the variability of species in a state of nature must have been nothing less than a revelation. Did the elder naturalists believe that Nature, having once for all formed her moulds and run into them her myriad species, had then gone to sleep? Here she was shown to have broken all moulds or to be incessantly making new ones. Did thinkers who accepted Darwinism, but were unwilling to abandon metaphysics, mythologically conceive of the creative power as pushing ever upwards along certain definite lines towards a dimly perceived goal? Here was the old Proteus found to be mocking all predetermined plans, flowing in all directions, taking all shapes, and masquerading in all guises. The entire vegetable and animal world was observed to be, as Heraclitus of old vaguely guessed, in constant flux. Every organ and every attribute of every species knows of no stationary state, but changes continually, and on this base of shifting quicksand is securely founded the whole theory of biological evolution. On the same foundation rests all social evolution. A rich harvest is impossible in a still unploughed field, but an initial attempt is now made to prove that the same universality of variation prevails among sociological as among biological species.

Political.

The social organism resembles certain low animal organisms, and like them varies in size. By annexations, renunciations, and losses, a country thus varies from one generation to another, and such variations may affect its specific character. The composite Austrian Empire, before Hungary was granted its old franchises, was predominantly German, and its chancellors were German; with the enfranchisement of Hungary it became almost Hungarian, and had a Hungarian chancellor; since the annexation of Bosnia and Herzegovina in 1878 it has become pre-eminently a Slavonic power, and naturally has a Slavonic chancellor. By the annexation of Alsace and Lorraine in the seventeenth century, France gained a footing on the right bank of the Rhine and at the same time acquired a notable influence over German courts and German literature; since its loss of them, its political and literary influence has almost vanished. World-wide Spain controlled the policy of the Papacy in the sixteenth century, was dominant in the Council of Trent, and deeply influenced the literature of Europe; without her empire she has shrunk to the dimensions of a merely national organism. The extent of the English county measured the personal force of the count or earl and varied with that; how significantly this contraction or expansion may affect a whole people, we perceive from the part that the two large provinces of Yorkshire and Lancashire played all through last century in the public life of England.

The relative dimensions of social organism continually vary. The French *ancien régime* was the scene of incessant conflicts among the executive, legislative, and judicial bodies. By their refusal to register royal edicts and ordinances, by the amendments they made in them, and the regulations they annexed to them, the *parlements* (courts of justice) constantly encroached on the legislative power. They encroached on the Executive by claiming the right to control the administration and the finances. During the agitated period of the Fronde they carried the assertion of these prerogatives to the point of civil war. On the other hand, the king trenched on the Judicature by the hearing of appeals, by evocations to the privy council of cases pending before any of the courts, and by granting leave to individuals to plead before the privy council in the first instance. The same variations are observable to-day. Under the Second Empire the Judicature was subservient to the Executive; it has long been subject to the Executive or the Legislature in turn. These, again, continually encroach on one another's sphere, now the one and now the other having the pre-eminence. The Judicature, in its turn, poaches on the preserves of the Legislature. "At a time of much hastily and recklessly devised legislation," remarks the Vicomte d'Avenel, "it illuminates, corrects, completes, or lets fall into desuetude the intentions of the law-makers. Reflecting changes of opinion and manners," he adds, "the jury is also slowly re-making the penal code, repealing some of its provisions by refusing to give effect to them, modifying others, and practically instituting new penalties."

It was long a Liberal tradition that the history of England records a steadfast constitutional development from despotism to freedom. Its real evolution might be graphically exhibited by means of such a "diagram of variation" as will be found on p. 67 of Wallace's *Darwinism*. While the dimensions of the Kingdom or Empire have, on the whole, advanced, like the body of Sciurus there outlined, the chief organs—the Executive, the Legislature, and the Judicature—have grown by a succession of zig-zags, like the head, tail, and feet of the same animal. Now this or the other power is on the crest of the wave, now in the trough of the sea; and the variations are often steep and abrupt.

It is equally an American tradition that the same three great organs of the national life of the United States have each been so effectually confined within their peculiar spheres that they have never left them.

The illusion is less and is yet real. All through their history each has pushed out in this direction and in that. Each has repeatedly tried to encroach on the domain of the others. Sometimes the President has the upper hand; sometimes Congress is on top; and the Supreme Court is continually repressing the expansion of Congress. The Senate and the House of Representatives are theoretically equal, but the Senate has grown at the expense of the House. In the States and the cities the Executive rises and falls with the character of the Governor or the Mayor; President Cleveland was popularly known as the Veto Mayor because of his unflinching exercise of his powers.

Ecclesiastical.

Perhaps it may be laid down as an axiom that all Churches and all religions have hived off sects and doctrinal varieties in exact proportion to their vitality. Buddhism has shown the fertility proper to hot countries, though it is not in the hottest countries that it has produced the most. While only eighteen sects were counted in Ceylon and Tibet, Chinese Buddhism has rejoiced in ninety-six.

Hinduism is equally marked by a propensity to develop new forms. Sir Henry Maine describes the Sikh religion as having a tendency to throw off sub-sects, each with novelties of doctrine and practice; and he adds that the same process goes on all over India.

Under the monotonous surface of Islam there is incessant variation. According to Baron d'Estournelles de Constant, the Algerian sects are innumerable and too fugitive to be seized. They appear, then suddenly disappear, and unexpectedly reappear elsewhere; they melt into one another, cross and ramify, change their name and their doctrines.

Early Christianity is the classical arena of sects and heresies. Eternal truths, it has been well said, are those on which man has varied most. "Every year, nay, every moon," wrote an ancient bishop, "we make new creeds to describe invisible mysteries." Gibbon distinguishes eighteen Arian sects, but declines to discriminate among the thousand shades of difference between Nestorius and Eutyches. In 1643 a Jesuit historian reckoned that there had been ninety heresies in all, but the estimate falls far short of the reality.

The half-ossified Greek Church furnishes the same evidence of vitality. Those best acquainted with Russia assert that new sects are there continually coming into existence, and that in such numbers as to defy numeration.

A winding-sheet has long lain over the soul of Spain, but its religious activity was at one time as great as its military and colonial ardour, and a Spanish professor has written a history of Spanish heresies in four big volumes.

Catholicism has various types. The sensuous Catholicism of the Italian differs from the sombre Catholicism of the Spaniard or the semi-Protestant Catholicism of the German. Travelling over Germany, M. Lavisse found different shades of piety in different countries, showing the rich variety of the religious sentiment. There is a great gulf fixed between the Ultramontane Catholicism of Maynooth and the very modern Catholicism of Baltimore.

Protestant Christianity is constantly hiving off new sects: some twenty years ago the *Times* estimated that 700 distinct denominations were spread over the surface of England. In the United States the number must be still greater. "From Roger Williams and Ann Hutchinson down to Abner Kneeland and William Garrison," writes Emerson about Boston, "there never was wanting some thorn of innovation and heresy."

Military.

Incessant variation on an immutable base is admitted by French military critics to be a summary of the history of the art of war. Procedures in use to-day are thrown aside to-morrow; rules valid one year are found to be inapplicable the next; and the tactics and strategy of one campaign are obsolete in its successor. Weapons are taken up, and dropped, and taken up again. Thus, the lance, which was being disused after the wars of 1866 and 1870 had apparently shown its inutility, came again into fashion before 1890; about two years ago (so it was stated) all German cavalry regiments were to be armed with it; since the Boer war it has been almost superseded by the rifle. The primitive mode of fighting was by straggling bands; as nations grew more crowded their armies fought in mass, and soldiers scorned to dodge a bullet or a shell; since 1870 troops fight in looser formation, as if the individual had come to be of more account. About 1889 charges of cavalry in mass were again favoured; since the South African war individualist fighting has once more come into vogue; but German military critics predict that in future European wars battles will be fought by gigantic masses. Among minor variations the South African war gave new birth to the mounted rifleman and the khaki uniform.

Ceremonial.

Habits and customs, manners and fashions obey the same unchangeable law of change. Recreations vary with the season and the year, and new ones are continually being devised. Croquet, tennis, rinking, cycling, golf, and ping-pong chase one another off the field. Fashions in dress are still more fugitive. The succession of female fashions is believed to embody the genius of caprice, but it could readily be shown that there is no excess in female attire that has not been matched and outdone by some whim or extravagance in male attire. While admitting that women's dress reveals "a great instability in details," Professor George Darwin holds that it "retains a general similarity from age to age." In point of fact, the costume of men and women alike, in every single item, has varied incessantly, in women no more than in men, in men no more than in women. With the vanishing of such apparitions as Cinq-Mars, Beau Brummell, and Count d'Orsay is not the scope of variation in male clothing sensibly lessened? Not by a hair's breadth. The splendour is gone, but the variety remains. The diagram of a century's coats would show hundreds of variations. A simple calculation would prove that so plain an article of male attire as a pair of trousers is susceptible of thirty or forty different shapes, and the tailor runs the gamut of most of them in a round of years.

Linguistic.

Mechanical inventions are so many variations in the practical sphere, and the records of the Patent Office show that a successful invention is only one among hundreds that have never come to fruition. But the grand human invention is language, and it, too, has grown by the selection of chance varieties among the myriads to which hand and voice are ever giving birth. The alphabet (to single out those arising from the art of writing) has been the theatre of endless variations that have not ceased even since the art of printing laid its leaden bands on the fluid mass. Place all existing

or extinct alphabets in parallel columns, and all will be perceived to have sprung from a single ancestor—Phœnician or transformed Egyptian. The development has taken place in the manner of all organic evolution. Spontaneous slight variations, due to accident, convenience, necessity, or caprice, have made all of the daughter-alphabets to differ sensibly from the mother-alphabet. In some letters a diagonal stroke has been substituted for the perpendicular; in others, a curve gradually approaches the straight line, which ultimately prevails. The position of an angle is changed; a flourish is added to a letter at the bottom; a cross stroke has a preponderance to one side; a triangular or circular top degenerates into a thick line; other characters rise above or descend below the line, or shoot out at an angle; and so on. How far such fanciful variations may carry an alphabet we perceive in Black Letter or Old English, which, or a congener of it, has been stereotyped into the modern German alphabet. Even printing does not arrest development, but gives increased scope to it. The variants of the artist who designs calendars and initial letters are of the same nature as those which made the Etruscan and Greek alphabets to differ from the Phœnician.

Literary and Aesthetic.

The range of variation is, perhaps, widest in poetry, where the free spirit moves in an ideal world and half creates its own objects. First, the rhythm varies. The ancient Greek poets, Chaucer and the earlier English poets, and all who trusted to their ear, "counted in each line the accents and not the syllables." With the loss of inspiration and the stiffening of the æsthetic sense, the fashion set in of mechanically counting the syllables, and we have such poetry as Pope's. Chatterton and Coleridge revived the old practice, converted it into a method, and varied the double by a triple rhythm. Scott multiplied the variations, ringing the changes on "the position of the accent in each foot, the number of the accents, and the number of the syllables in each foot." Next, the line, couplet, or stanza varies. In the first history of English literature that has been fruitfully impregnated by the evolutionist idea, Professor Macmillan Brown has luminously traced the variations of metrical forms through the second half of the eighteenth century. Two stand out conspicuous—the heroic couplet and blank verse. In Milton blank verse reaches the high-water mark by its cunning inversions, its complex harmonies, and its sublimity. Then it is displaced for half a century by the heroic couplet. When it comes back its character has completely changed. Descriptive in Thomson, stilted and ethical in Akenside and Warton, simple and straightforward in Cowper, picturesque and suggestive in Rogers and Campbell, narrative in Southey and Landor, austere in Wordsworth, and plastic in the Brownings, it is once more richly musical in Tennyson. The rhymed couplet runs a similar gamut of variations. Lastly, the structure of the poem varies. There are five standard types of the sonnet; there are six chief variations of it in Italy, where it has been most cultivated; the French, too, have delighted in experimenting on it, and there is a succession of English varieties; while the sextet, or group of six concluding lines, has been rhymed in eighteen different manners.

It might be better to say nothing than to say too little on the highest province of man's activity, but a single instance may be adduced from the æsthetic sphere. Hardly anything seems more likely to be stereotyped than the music of an oratorio. Yet great diversities have marked both the score and the performance of the *Messiah*. The score has been edited by a succession of musicians. Mozart supplied new harmonies and new accompaniments. Hiller incorporated a version of his own with Mozart's score. Bridge tried to restore it as Handel left it. Prout fills up vacant harmonies, eliminates some additions, restores Handel's orchestration, and deletes Mozart's false counterpoint. To changes of score have been added variations of performance: the harpsichord has been disused; the organ is larger; the composition of the orchestra has varied at different periods; as have also the proportions of the band and the chorus. There have been many *Messiahs*.

Such are a few examples, culled from a multitude, of variations among sociological species. Evidently, the genius of variety, which has made the outer world so bright to eye and ear, has clothed in shapes as multiform the far more complex world of man's social strivings and achievements. May we not conclude that civil as well as natural history presents unasked all those new openings and new paths which, selected and pursued, lead to higher stages of civilisation?

Some Tibetan Animals.

By R. LYDEKKER.

NATURALISTS are speculating whether the opening-up of Tibet, which is practically sure to follow the present expedition to Lhasa, will result in the discovery of any new animals of special interest. So far as the smaller mammals, such as mice, rats, squirrels, shrews, &c., are concerned, it cannot be doubted that systematic collecting will be sure to yield a certain number of new forms. With regard to the larger mammals, the case is, however, different, and it would be unwise to expect that any strikingly new type is likely to turn up, although important information will doubtless be obtained in due course with regard to the mode of life and the nature of the habitat of several of the mammals already known to us. The reasons for taking this somewhat discouraging view as to the prospects of discovering new animals of large size in Tibet are as follows:—

In the first place, although few Europeans have hitherto actually reached Lhasa, the country has been traversed to the northwards of that city from east to west—notably, by Messrs. Bower and Thorold in 1892—by travellers who have done all in their power to collect specimens of the fauna; while many sportsmen, naturalists, and collectors have penetrated far into the interior from either the eastern or the western border. Moreover, the typical Tibetan fauna inhabiting the high plateaus above 14,000 feet is closely allied to, if not absolutely identical with that of Eastern Ladak, which lies within the limits of Kashmir territory, and has therefore for many years past been readily accessible to Europeans. On the other hand, the mammals of the somewhat lower and apparently more or less wooded districts forming the eastern portion of Tibet range into the north-western provinces of China, such as Shansi and Kansu, where they have of late years been collected by Mr. F. W. Styan, an English tea-planter. Not that our information with regard to the mammals of Eastern Tibet depends by any means solely on the collections made in Kansu and Shansi. On the contrary, the great French missionary explorer, Abbé

David, succeeded many years ago in penetrating into the heart of the Moupin district of Eastern Tibet, whence he brought back a number of mammals belonging to types previously unknown to science. Practically all that has resulted from subsequent exploration and collection is to prove the extension of the range of these peculiar types into Western China, and to add to them a few species differing only in comparatively trivial features. The absence of any distinctly new types in this West Chinese fauna seems to point to the improbability of any striking novelty among the larger types of animal life remaining to be discovered in Tibet.

Of the strange animals first brought from Eastern Tibet by Abbe David, and subsequently obtained by Mr. Styan in Western China, by far the most remarkable is

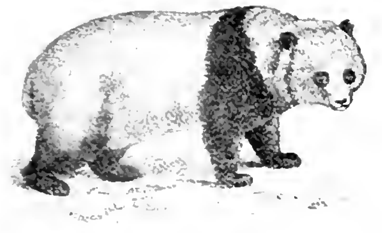


Fig. 1.—Great Panda.

the creature now known to naturalists as the great panda (*Æluropus melanoleucus*), although at one time denominated the parti-coloured bear (fig. 1). In appearance this animal is, indeed, strangely bear-like, although far inferior in bodily size to most members of the *Ursidæ*: the rudimentary tail, plantigrade feet, short ears, and broad head being all ursine features. Moreover, it is not a little remarkable that a species of true bear (*Ursus pruinosus*) inhabiting Tibet not infrequently presents a type of coloration approximating to that of the great panda, in which the legs and under-parts, together with a band across the shoulders and a ring round each eye, are sooty black, while all the rest is pure white. On the other hand, when the face of the great panda is compared with that of the much smaller and long-tailed arboreal animal inhabiting the Eastern Himalaya, and known as the true panda (*Ælurus fulgens*), a marked resemblance can be detected, and when careful comparison between the teeth

Fig. 2. Teeth of right side of jaw of Great Panda.

and skeletons of the two animals is made, it becomes apparent that the great panda is much more nearly related to the long-tailed species than it is to the bears. In fact, these two animals appear to be the Old World representatives of the raccoons and coatis of America, and thus afford one more instance of the close affinity existing between the faunas of Eastern Asia and North America. The teeth of the great panda (fig. 2) are most beautiful and interesting objects—on the whole approaching much nearer to those of the lesser panda than to the ursine type. Of the habits of the great panda, we are at present in complete ignorance; but on this point we may hope in time to be enlightened by the opening-up of Tibet. Whether we may ever expect to see such a wonderful creature alive in the Regent's Park, it is difficult even to guess. Probably the great panda is a native of the more or less wooded districts of Eastern Tibet, and not of the arid and elevated central plateau.

The same must undoubtedly be the case with the Tibetan snub-nosed monkey (*Rhinopithecus roxellanæ*) (fig. 3), which was likewise the first known representative of a new generic type discovered in the Moupin district of Eastern Tibet by the Abbé David. It has, however, been subsequently obtained in Szechuan, while a second representative of the genus has been discovered in N.W. China and a third in the mountains bordering

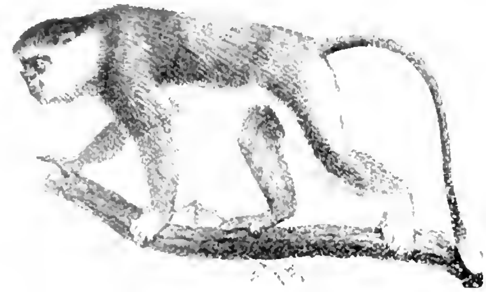


Fig 3. Orange Snub-nosed Monkey.

the Mekong River. That the Tibetan representative of the snub nosed monkeys, at all events, is a native of a cold climate may be inferred from its massive and "chubby" build and its thick coat, which in winter forms a long silky mantle of great beauty on the back. As to the peculiar form of the nose, so utterly unlike that of ordinary monkeys, the suspicion arises that it may be in some way connected with life at a high altitude, seeing that the Chiru antelope, to be noticed later on, has gone in for a very strange development in the way of noses. At present, however, we are very much in the dark as to the relative height of the districts in which these strange monkeys are found.

Nothing special need be said with regard to the above-mentioned Tibetan bear, except that it appears to be a peculiar species. The mere mention that the snow-leopard (*Felis uncia*) is an inhabitant of the Tibet plateau must likewise suffice, seeing that this handsome cat has a wide range in Central Asia.

Several species of deer are found in or near Tibet, although all of them appear to be confined to the wooded districts bordering the arid central plateau. The finest of these is undoubtedly the shou (*Cervus affinis*), a species allied to the red deer, inhabiting the forests somewhere near the head of the Chumbi Valley, in Sikhim. This deer is very rare in collections, where it is represented mainly by skulls and antlers, but it is probable that specimens will before long be forthcoming. A young individual is stated to have been killed during the early days of the Tibet expedition. Thorold's deer (*C. albirostris*) is a rather smaller and much darker coloured species, readily distinguished by its white muzzle and the comparatively simple antlers. It exhibits the relatively heavy build characteristic of species inhabiting cold countries. This fine deer was first obtained in the wooded districts to the north of Lhasa by the Russian explorer Przewalski, and subsequently by the English traveller Dr. Thorold, to whom the British Museum is indebted for its specimen. The third deer peculiar to the country is the Tibetan tufted deer (*Elaphodus cephalophus*), a species of the approximate size of a roebuck, and typifying a peculiar genus. In general character this deer is nearly related to the Indian and Malay muntjacs (*Cervulus*), the

bucks being armed with similar long tusks in the upper jaw, but the antlers are even smaller than in the latter, being reduced to mere knobs, and there are distinctive peculiarities in the skull. This interesting deer was first obtained by the Abbé David in the Moupin district of Eastern Tibet, but a second species was soon afterwards secured near Ningpo, in Eastern China, while a third kind has recently been described from the mountains near Ichang, in Central China.

In hollow-horned ruminants (oxen, sheep, antelopes, &c.) Tibet is specially rich, many of the species being peculiar to the country, where several of them are confined to the high central arid plateau. The first place in this group must undoubtedly be assigned to the yak (*Bos grunniens*), one of the finest and largest of the wild oxen, specially characterised by the great growth of long shaggy hair along the flanks and under-parts of the body and the well-known bushy tail. In this country, unfortunately, a somewhat false impression of the yak is prevalent, owing to the fact that all the specimens hitherto imported belong either to a small domesticated breed from Darjiling, or to half-breeds: the latter being generally black and white, instead of the uniform black distinctive of the pure-bred and wild animal. None of such half-breeds can compare with the magnificent half-tamed animals kept by the natives of the elevated Rupsu plateau, to the south of the Indus, where they afford the only means of transport by this route between Ladak and India. And even these Rupsu beasts are inferior to the wild yak, which stands nearly six feet at the shoulder. These magnificent animals are absolutely confined to the arid central plateau, on some parts of which, hitherto closed to Europeans, they are said to be comparatively numerous.

Another native of the same bare plateau is the Tibetan argali, or wild sheep (*Ovis ammon hodgsoni*), a magnificent animal, with horns of wonderfully massive proportions in the old rams. Since, however, this species is only a local variety of the true argali of Central Asia generally, it is of less interest than the types exclusively confined to the country. The same may be said of the shapoo, or Tibetan urial (*Ovis vignei*), which is the typical race of a smaller race of wild sheep, whose range extends in one direction into North-Western India and in another into Persia. A third species of wild sheep, the bharal, or blue sheep (*Ovis nahura*), readily distinguished by its smooth and peculiarly curved horns and close grey-blue coat with black points, is, however, absolutely characteristic of the arid Tibetan plateau, on which it is found in large flocks. On the other hand, the Asiatic ibex (*Capra sibirica*), which frequents the more craggy ground instead of the rolling uplands, is a species with a very wide distribution in Central Asia.

Although the yak and the bharal may be regarded as representing by themselves distinct subgeneric types, all the hollow-horned ruminants hitherto mentioned are members of widely-spread genera. We now come, however, to a remarkable species which is the sole representative of a genus quite apart from any other, and absolutely restricted to the arid central plateau. This is the graceful chiru, or Tibetan antelope (*Pantholops hodgsoni*), of which the bucks are armed with long, slender, and heavily-ridged horns of an altogether peculiar type (fig. 4), while the does are hornless. Possibly this handsome antelope may be the original of the mythical unicorn, a solitary buck, when seen in profile, looking exactly as if it had but a single long straight horn. Although far from uncommon, chiru are very wary, and consequently difficult to approach. Like all Tibetan animals, they have a firm thick coat, formed in this instance of close woolly hair of a grey fawn colour. The most peculiar feature about the chiru is, however, its swollen, puffy nose, which is probably connected with breathing a highly rarified atmosphere. This antelope has never been exhibited alive in a menagerie, and, as is the case with the other large mammals of the central desert plateau of Tibet, it would probably not live if removed from its native uplands to ordinary levels. A second antelope inhabiting the same country as the chiru is the goa (*Gazella picticaudata*), a member of the gazelle group characterised by the peculiar form of the horns of the bucks and certain features of coloration, whereby it is markedly distinguished from all its kindred save one or two other Central Asiatic species.

The most remarkable of all the Tibetan hollow-horned ruminants is, however, the takin (*Budorcas taxicolor*), of which the typical representative inhabits the Mishmi Hills, in the south-east corner of the country, immediately north of the Assam Valley, while a second variety is found further east, in the Moupin district. The takin, which may be compared in size to a Kerry cow, is a clumsily-built brute with yellowish-brown hair and curiously curved horns, which in some degree recall those of the South African white-tailed gnu. Its nearest relatives appear to be the serows of the outer Himalaya and the Malay countries, which are in many respects intermediate between goats and antelopes. As it lacks the thick woolly coat of the chiru and the goa, there can be little doubt that it inhabits a country with a less severe climate than that of the Central Tibetan plateau, and it is probably a native of the more or less wooded districts of comparatively low elevation forming the outskirts of Tibet. It is one of the few large animals that hitherto appears never to have fallen to the rifle of a European.

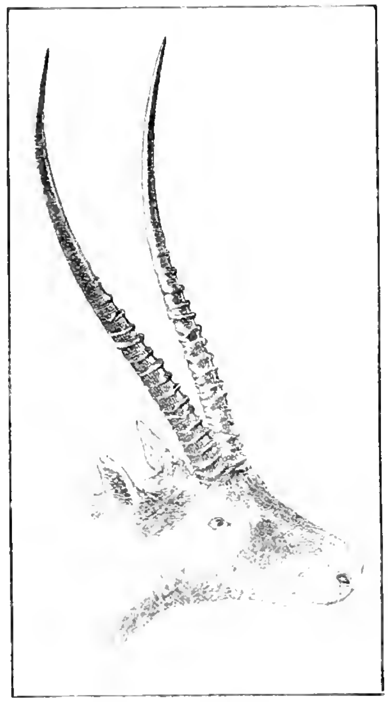


Fig. 4.—Head of Male Chiru.

With the large and handsome wild ass or wild horse (for it is, to a great extent, intermediate between the two), locally known as the kiang, we return once more to a characteristic denizen of the desert plateau forming the heart of Tibet. The kiang (*Equus hemionus kiang*) stands

close on 13 hands at the shoulder, and is of a bright red bay in colour, with the muzzle, under-parts, and legs dazzling white. Its ears (Fig. 5) are relatively much shorter and its hoofs much broader than in the true wild asses of Africa, from which it also differs markedly in colour, while its cry is somewhat between a bray and a neigh. In the higher and more open parts of Ladak, kiang are to be seen in large numbers; and they come galloping round the convoy of the traveller in circles, with their heads carried high in the air, so that the face is almost horizontal. Whether the kiang is entitled to be ranked as a distinct species, or whether it should be regarded merely as a variety of the chigetai or wild ass of Mongolia and the lowlands of Central Asia generally, is a moot point; but, be this as it may, the creature is absolutely confined to the central desert plateau of Tibet, where in winter it develops a coat as thick and rough as a door-mat, in order to afford effectual protection against the rigours of that season at such an altitude.

Fig. 5.—Head of Kiang.

In addition to the foregoing list of large mammals, Tibet is likewise the home of a number of peculiar species of smaller size. Among these it must, however, suffice to make mention of only two on the present occasion. Firstly, there is a remarkable species of water-shrew, differing in many respects from the common water-shrew (*Neomys fodiens*), and accordingly referred to a genus by itself under the name of *Nectogale elegans*. Of that genus it is the sole known representative. When we are fully acquainted with it, the Tibetan palm-civet (*Paradoxurus laniger*), at present known only by a single skin obtained so long ago as 1836, will prove almost as interesting a species, for it is quite probable that it will turn out to be generically distinct from the palm-civets of India and the Malay countries, from which it differs by its woolly coat.

Such a large number of peculiar generic and specific types of mammals restricted to a continental area of the comparatively small size of the Tibetan plateau is a feature unparalleled elsewhere, and to find an analogous instance we must take the case of an island like Celebes, which has been isolated for ages from all surrounding lands. It would seem, therefore, that Tibet has been similarly isolated, so far as immigration and emigration of its animal fauna is concerned, for a vast period of time; an insulation due, doubtless, to its great elevation above the sea-level, and the consequent severity of its climate and rarity of its atmosphere. Climatic peculiarities of this nature can only be endured by animals specially adapted to such conditions of existence; and it is accordingly only natural to expect that when once the Tibetan fauna had become modified for the needs of its environment it would have remained permanently isolated from that of the surrounding countries.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

Artificial Illumination.—It seems not unlikely that all our present methods of artificial illumination will be regarded as elementary and crude in the not very distant future. We aim at getting enough light, but are not at all particular as to its quality. When the colour of an artificial light is modified, it is generally with the idea of making the lamp more ornamental, rather than for the sake of the light itself, for shades and globes are made of all varieties of tint. The result is that coloured objects appear different according to whether they are viewed by daylight or lamplight, the variation extending even to the character of the lamplight. For a long time we were contented with analogous photographic discrepancies, using only plates that render bright yellow and red as if they were dark grey or black, and some dark blues as if they were white, but we are now becoming alive to the importance of such errors. I have a piece of plaid material that has broad stripes of a light brick red, and a dark blue, which if photographed on an ordinary or even an isochromatic plate, shows no trace of the pattern. A photographic falsification of this kind would not be tolerated, but such a change as I noticed a little while ago, when a blue silk dress appeared to be a rich brown by the artificial light provided, would probably either pass unobserved or be regarded as a curious and unavoidable incident. It may be argued that daylight changes, and so indeed it does. Reds are hardly distinguishable from black, and blues and greens become grey as the night approaches, and twilight is the more beautiful because of it. But to bring the changes that are associated with the dying day into the full glare of a brilliant illumination ought to offend our good taste. A step forward in artificial illumination has recently been made by Messrs. W. M. Gardner and A. Dufton in the construction of a lamp for colour matching. They employ an arc light, and by means of suitable media absorb that part of the light that is excessive, and so obtain an illumination which they state "is precisely of the same character as that of good daylight from a north sky, and has the advantage over ordinary daylight of being perfectly uniform and unchangeable." Although intended only for matching colours, the same principle might be applied to ordinary illumination, and this offers a far greater and more important field for such modifications of artificial lights.

The Variability of Daylight.—The changeable character of daylight has a very large influence on photographic work, and therefore must be studied by those who would get better results than are obtained by the careless snap-shotter. As the sun gets low the daylight gets markedly more yellow, and we have from time to time been instructed that the excessive blue sensitiveness of gelatino-bromide plates becomes so far negatived on account of this change that it is not necessary to obviate it by the use of a yellow or orange-coloured screen. Whether or not this is so depends on what the photographer wants. If he seeks to photograph an evening effect as if it were lit by such light as is given by the sun only when he is high up in the heavens, while the general effect is such as can be obtained only when he approaches the horizon, then he may omit the coloured screen. But if his aim is to photograph the scene before him as it is, there is as

much need for the yellow screen at sunset as at midday. The changes in light obviously affect all coloured objects. If a photograph in natural colours is made so successfully that it is an exact reproduction of the original as seen by full daylight, it may be different from the original when they are compared by evening light, because the colours of the photograph are only imitations of those of the object, and they may, and probably will, be differently affected by the change in the character of the light. If anyone desires a good illustration of the effect on colours of daylight of different kinds, he has only to get one of the separating black papers from a "premo-film-pack" as supplied by the Kodak Company, and see how the red printing on it appears by ordinary daylight and again by twilight. He may find in the latter case that the inscription has apparently vanished, or, if he can see traces of it, he will probably be unable to decipher it. If the red constituent of the light has gone, a pure red will appear black and be indistinguishable from it.

These changes in the light that reaches us from the sun are generally ascribed to the terrestrial atmosphere, particularly the aqueous vapour in it, and the fact that the light from the sun has to pass through more and more of the atmosphere as it sinks lower and lower. But the sun also has an atmosphere, and it is possible that variations in this may contribute to the changes that we observe. Professor Langley, who has worked at this subject for about thirty years, especially by means of his bolometer, has recently stated that there is "an increasing probability that the solar radiation itself varies in a degree appreciable to our present means of daily observation, and a strengthening of the belief that it probably varied through much greater ranges in the past, and may do so again in the future."

The Keeping of Sensitive Plates.—The time that sensitive material can be relied upon to maintain its good qualities is of great practical interest. Plates in England, if stored so that they shall be reasonably free from foul air, will last a long time in good condition if the emulsion is not very rapid. I recently had occasion to use some "spectrum" plates that are six years old, and found that they had a full red and green sensitiveness, that they worked clean, and, generally, were in good condition. They are rather slow, for the most rapid spectrum plates are six or eight times as fast. Slow plates of all kinds, if well made, will keep in good condition for an astonishing length of time. Ordinary fast isochromatic plates I have found when a year or so old to require about double the exposure they did when new, but otherwise satisfactory. The ultra rapid plates, whether colour sensitised or not, should be used as soon as possible after purchase. I have found such plates when a few months old to be only half as fast as at first, and to show considerable fog. It is obvious that a higher degree of sensitiveness must mean a want of stability, for sensitiveness and stability are directly opposed to each other. While, therefore, it is the makers' aim to provide plates that will keep well under all ordinary conditions, the user of them should bear in mind that high sensitiveness in plates means that they are affected by very feeble forces, and as it is impossible to keep them isolated from adverse influences whatever care is taken in their preservation, the more sensitive a plate, other things being equal, the shorter its life.

THE Thornton Pickard Co has sent us a prospectus of their Annual Competition, open to users of their apparatus The prizes this year consist of twenty equal amounts of £5 in cash The Competition closes on October 1, and full particulars and entry forms may be had free on application to them at Altrincham.

NOTES

ASTRONOMICAL.

The Ninth Satellite of Saturn.

IT will be remembered that five years ago Prof. W. H. Pickering announced the discovery of a new and faint satellite of Saturn with a period of about a year and a half. The satellite, to which he gave the name of Phœbe, was discovered upon photographs taken with the 24-inch Bruce telescope. Eleven photographs, taken by Mr. Frost at the Arequipa Observatory, under the direction of Prof. Bailey, have enabled Prof. Pickering to follow the satellite from April 16 to June 9 of the present year, and to correct its ephemeris; and a full discussion of its orbit will appear in a few weeks, in a forthcoming volume of the Annals of the Harvard College Observatory.

* * *

Comet 1903 (Borrelly) and Light-Pressure.

In a paper in the "Astrophysical Journal" for July, Mr. S. A. Mitchell deals with the question of the formation of cometary tails by the influence of light-pressure. The researches of Bredichin had shown comets' tails to be of three different types according to the intensity of the repulsive forces which Bredichin explained as electrical in nature. This Lebedew showed not to have a sound physical basis, but Arrhenius has recently substituted the pressure of light. For a little cube of water with an edge of one micron, the pressure of the sun's light on it, at the sun's surface, is exactly equal to its weight; for a smaller cube the pressure would be greater than the weight, and hence the particle would be repelled. Measures of the angles between the tails of Comet Borrelly and its radius vector, made by Mr. Sebastian Albrecht on thirty-two photographs taken between June 22 and August 18, 1903, gave somewhat discordant results for the principal tail, but the mean of the best values gives the repulsive force as 18·47 times gravity. The values for the secondary tail agreed much better, and their mean was 1·824; the last four values gave a mean of 1·460, seeming to show the existence of a third tail, and this appeared to be corroborated from the photographs of August 12 and 15. The size of the particles forming the tails would be respectively 0·1, 1, and 1·33 microns. Mr. Mitchell concludes that there seemed to be a lagging even behind the direction given by the repulsive force; in other words, that the value of the repulsive force may increase as the comet approaches the sun. This increase, he considers, is in part at least real, and due to the more violent action of the gases liberated as the comet approaches the sun.

* * *

The Position of the Galactic Plane.

A most important and lucid paper by Professor Simon Newcomb has been published on the position of the galactic and other principal planes toward which the stars tend to crowd. He states the problem thus: "It is well known that the sky appears to us poorest in stars in the regions around the poles of the galaxy, and that it continually grows richer at a rate which is slow at first but more rapid afterwards, from the poles toward the galactic circle." Within the galactic girdle, the thickness of the stars in space is approximately constant, but in the Milky Way itself it is obvious that it consists of agglomerations of stars which have often fairly well defined boundaries; the stars here are much thicker than outside the girdle. The chief object of this paper is to determine this principal galactic plane, and also to determine whether the non-galactic stars condense towards this same plane or towards

other planes. Professor Newcomb makes no hypothesis as to the actual thickness of stars in space, but considers only their apparent distribution in the sky; and the problem is thus stated for mathematical discussion: "Let us suppose a plane taken at pleasure passing through our position in the universe, which point we take as the origin of co-ordinates. This plane will cut the celestial sphere in a great circle. The perpendicular distance of a star from the plane will then be represented by the sine of its distance from the great circle. Let us form the sum of the squares of these sines for the whole system of stars which we consider. The value of this sum will vary with the position which we assign to the plane. The principal plane of condensation, as I define it, is that for which the sum in question is a minimum." The working out of these expressions of condition gives a cubic equation whose three roots are the three principal planes of the system of stars; the smallest root corresponding to the plane of condensation, and the other planes being at right angles to it. If the system of stars should lie on a great circle then the value of the smallest root, corresponding to the plane of condensation, will be zero. In considering the galaxy a difficulty came up with regard to the great bifurcation between Cygnus and Aquila, and Professor Newcomb therefore considers two cases, one including the branch in the galactic system, and one omitting it. In neither of the two cases does he find that the central plane of the galaxy is accurately a great circle in the sphere; in other words the solar system does not lie quite centrally within the band of the Milky Way. Next Professor Newcomb considers "The Belt," or band of bright stars which first Sir John Herschel and later Gould showed as lying on a great circle which cut the plane of the galaxy at an angle of about 20°. Professor Newcomb shows indeed that this angle of deviation from the plane of the galaxy is only about 11°, from the consideration of 36 of these bright stars which do not exhibit large proper motion. Thirdly, he considers the plane of all stars to mag. 2·5; of all stars to mag. 3·5; of all the lucid stars; and finally for the Wolf-Rayet or Fifth Type stars. The following table gives the positions of the poles of these planes:—

		R.A.		Dec.
Galactic plane (omitting branch)	..	192·8	..	+ 27·2
Galactic plane (including branch)	..	191·1	..	26·8
Gould's Belt, as found by Gould	..	171·2	..	30·0
The Belt, from 36 stars of small p.m.	..	179·6	..	26·4
Plane of all stars to mag. 2·5 ..	..	181·2	..	17·4
Plane of all stars to mag. 3·5 ..	..	180·0	..	21·5
Plane of all lucid stars	..	180·0	..	21·5
Plane of the fifth type stars ..	..	190·9	..	26·7

From a consideration of the richness of the galactic region, Professor Newcomb concludes that it the galactic agglomerations were excluded from consideration, the crowding of the lucid stars towards their principal plane would be scarcely, if at all, greater than what we might expect as the result of the irregularity of chance distribution, and that we should still find a continuous increase in the richness of the sky from the poles to the galactic circle, where it would probably be nearly twice as great as at the poles.

BOTANICAL.

THOUGH the ovary of the oak (*Quercus*) is usually more or less perfectly three-celled, and each cell contains two ovules, the mature fruit, known to everybody as the acorn, nearly always contains only one seed, and therefore produces only one seedling. Professor Coker, in the January number of the *Botanical Gazette*, refers to acorns which invariably contain two or three seeds, and one is illustrated giving rise to three vigorous seedlings. These acorns were produced by a rock chestnut oak (*Quercus prinus*), found near Baltimore, Maryland. The same writer has met with a two-seeded acorn of *Q. velutina*, but in this instance the other acorns of the same tree were one-seeded.

Professor Coker also has an interesting note in the same publication on "Spore Distribution in Liverworts." He alludes to the fact that terrestrial species usually have their capsules raised on elongated stalks, while in the case of those that grow on trees the stalk of the capsule is seldom long, as in the latter the position of the plants some distance above the ground ensures the distribution of the spores on the dehiscence of the capsules. He shows, however, that in *Porella platyphylla*, though the vegetative shoots are closely adpressed to the bark of the tree, the fertile ones, just before the ripening of the spores, bend away from it and often project a centimetre or more. In consequence of this the spores get more exposure to winds, which prevent their falling and remaining amongst the leaves of the parent plant.

In recent volumes of the *Comptes Rendus*, Monsieur G. Bonnier has some interesting and important papers giving the methods and results of his cultural experiments on plants in the Mediterranean region, with a view to the modifications of their anatomical structure. The experiments have been carried on at Toulon, and at Fontainebleau, thirty-seven miles S.S.E. of Paris. Fifty perennial species were selected, each of which was split into two portions, one for cultivation at Toulon, the other at Fontainebleau. The plants were procured from the latter place, and the soil in which both sets were cultivated from Toulon. The results obtained are very interesting. Toulon has a less uniform climate than Fontainebleau, and is drier in summer, conditions which would be expected to lead to some modifications of the internal structure of the stems and leaves. The plants grown at Toulon have acquired the same peculiarities of anatomical structure as those of the plants of the same species found growing wild in that locality. The annual ring of wood was thicker and contained vessels of a larger calibre, while the leaf characters were more xerophytic than in the Fontainebleau specimens. Instances of remarkable variations in size and habit of plants grown in different latitudes and at different elevations are familiar to most botanists, and an extensive knowledge of such variations is most important to the systematist, who is often perplexed in determining whether characters with which he has to deal are of specific value, or whether they merely represent the influence of local conditions.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Infanticide by a Meadow-Pipit.

LORD BALFOUR OF BURLEIGH, in a letter to the *Field* for July 16, describes, on the authority of his keeper, how a meadow-pipit ejected its own young from the nest in favour of a young cuckoo.

The foundling, it appears, emerged from the shell some forty-eight hours after the first of the young pipits, but a few hours later the pipit was found outside the nest. Knowing nothing of the evil reputation of young cuckoos he replaced the nestling and watched for the hatching of the remaining eggs. This took place a few hours later, and he then saw what he believed to be the hen bird "remove first one and then the other and deposit her own offspring outside her home. Not being yet satisfied, he put two of the young ones back into the nest, and to avoid possibility of mistake watched operations a second time. He again saw the unnatural mother eject her own young in favour of the stranger. The young cuckoo was fed and tended by both titlarks and a few days after left the nest."

This account is certainly of extreme interest and is probably unique. There can be no doubt about the fact that normally the young cuckoo performs the work of eviction. Indeed, according to most observers, this little monster is specially endowed by Nature with a hollow back into which the victims are forced by the wings and held there till the edge of the nest is reached, when they are toppled over. Concerning this hollow back we shall have something to say later.

This letter was followed by another (July 23) from a correspondent who, after reading Lord Balfour's letter and finding dead wagtails outside the nest, came to the conclusion that

this eviction must have been the work of the parent wagtails, owing to the tender age and and helplessness of the cuckoo. But this is purely supposition.

Cuckoo Watching over its Young.

The cuckoo would appear to be a much maligned bird, or at least to be credited with fewer virtues than it really possesses. In the *Field* of August 6 a writer describes how a young and full-fledged cuckoo was seen on a lawn making "a noise more like squeaking than chirping," whilst overhead two old cuckoos were hovering. On three consecutive days the same thing was observed. In this account, however, there is no mention of their tender solicitude taking a more practical shape, since neither of the old birds appear to have fed their putative offspring. Since the cuckoo is well known to be a polygamist, he is probably at most only mildly interested in any of his numerous offspring which must be scattered over the area of his sojourn during his short stay in this country.

Sexual Differences in the Wing of the Lapwing.

Hitherto the sexes of the lapwing (*Vanellus cristatus*) have been regarded by ornithologists as almost indistinguishable. In the *Field* (July 16), Mr. F. W. Frohawk shows conclusively that a very ready distinction may be drawn between the sexes at all ages, inasmuch as in the male the primaries from the 3rd to the 10th are both broader and longer than in the female; so much so that in the outstretched wing the primaries of the male form a broad round fan projecting conspicuously beyond the line of the free edge of the secondaries. Further, in the male the secondaries grow shorter from without inwards so as to impart a sinuous line to the free edge of this region of the wing. It is strange that in so familiar a bird this difference should so long have remained undetected. As Mr. Frohawk points out, it is probably this great fan-shaped expansion of the wing which makes the remarkable flight of the lapwing at the breeding season possible.

Decrease in Weight of Incubating Eggs.

Mr. H. S. Gladstone, in the last number of the *Field*, contributes an extremely interesting note wherein he shows, by a series of careful weighings, that eggs lose in weight during incubation. Experimenting with pheasants' eggs he shows, in a table of averages, that between the first day and the twenty-third the loss is as much as 2 drs. 12 grs. Weighed every fourth day the loss on the average varies between 9 and 10 grs. The history of any single egg is sometimes very striking: thus an egg which, just laid, weighed 17 drs. 19 grs. at the twenty-third day only turned the scale at 13 drs. 10 grs.

Blue-throat near London.

Mr. E. Chubb, in the *Zoologist* for July, records the occurrence of the Blue-throat (*Cyanecula suecica*) at Sheen Common on June 17. There can be no doubt about the identification in this case, for he remarks: "What struck me first was the beautiful band of light lilac round the throat. . . . as it settled on a fence within a few yards of where I stood." Though he could not make out the colour of the spot in the throat, Mr. Chubb inclines to the belief that this bird was of the red-spotted species, and in this we agree. The white spot would have been conspicuous: moreover it is a much rarer visitor.

Long-eared Owl Nesting on the Ground.

Since the long-eared owl (*Asio otus*) very rarely nests on the ground it is interesting to note that a further instance has occurred at Witton Park, near Blackburn. A description of the nest, together with an excellent picture of the female and young, appears in the *Zoologist* for July.

ZOOLOGICAL.

Gibbons in Sumatra.

According to Dr. W. Volz, who has recently been travelling in the country, the two banks of the Lematang River in the Palembang district of Sumatra are respectively inhabited by different species of long-armed apes, or gibbons. On the west bank is found the siamang (*Hylobates syndactylus*), while the country to the east of the river is the home of the agile gibbon, or wau-wau (*H. agilis*). It is not necessary to capture, or even to see, specimens of the two species in order to satisfy oneself as to their limitations, for they may be readily distinguished by their cries, the siamang calling in a single note, whereas the cry of the wau-wau forms two notes. The remarkable thing about their distribution in Palembang is that the two species are found in company throughout the rest of Sumatra; and even in Palembang itself they inhabit the mountain districts, where the river is so narrow that they could easily leap over it, and yet they keep to the opposite banks.

* * *

Papers Read.

At the meeting of the Entomological Society of London held on June 1, Colonel Swinhoe read a paper on Tropical African moths of the family *Geometridae*; Mr. W. L. Distant contributed some notes on additions to our knowledge of the cicalas (*Cicadidae*); the President communicated an article by Mr. G. F. Leigh on series of butterflies of the species *Papilio* [illegible] and *Hypolimnas misippus*; while Mr. E. Saunders described collections of Hymenoptera from Majorca and Spain.

* * *

Wild Asses and the Quagga.

The August issue of the *Proceedings* of the Zoological Society of London contains two coloured plates of Asiatic wild asses now living in the Duke of Bedford's park at Woburn. The two species portrayed are the kiang, or wild ass of Tibet, and the chigetai, or wild ass of Mongolia. The description of the two animals is by Mr. Lydekker, who, we understand, has written a paper on wild asses generally, which will shortly be published in *Novitates Zoologicae*, the official journal of Mr. Rothschild's splendid private museum at Tring. To the journal first mentioned Mr. Lydekker also contributes some notes on the extinct quagga, in which he confirms the alleged existence in the skull of that species of a vestige of the cavity for the face-gland which was fully developed in the ancestral three-toed hipparion. He also refers to the recent gift to the British Museum of a portion of the head-skin of a quagga shot in the forties, which had been made into a sheath for a hunting-knife.

* * *

The Lily-Cradled Bat.

A gorgeously coloured Oriental bat (*Kerivoula picta*), whose wings are brilliant orange and black, has been generally supposed to owe this coloration to a protective resemblance to the decaying leaves and ripe fruit of the plantain, among which it commonly dwells. A correspondent of Captain Stanley Flower has, however, stated in one district of Siam this bat reposes in the flower of the Cala lily. The colour of this lily is not stated, but it may be presumed that it is somewhat similar to that of the bat. In commenting on the statement, Dr. Jentink, of Leyden, remarks that "it sounds like a wonderful tale, a golden red and black coloured bat sleeping in a lily-flower!" Can it be that the plaintain bat has a double colour-adaptation—to the plantain in India and to the Cala lily in Siam?

* * *

Alleged Cannibalism in Snakes.

In a recent issue of the *Journal* of the Bombay Natural History Society numerous instances are cited of snakes devouring one another; this kind of diet being stigmatised as "cannibalism." Seeing, however, that in all the instances cited in this particular communication the devourer was of a different species to the one devoured, this is surely a misnomer. We might as well say that it is cannibalism on the part of a great grey shrike to kill and eat a sparrow, or of a rat to devour a field-mouse. When, as happened some years ago in the Zoological Society's Menagerie

a python devours one of its own kind, we have an undoubted case of cannibalism; but it is highly improbable that acts of this description ever take place in a state of nature.

* * *

Black Leopards.

Many people persist in believing that the black leopard is a distinct species. An additional piece of evidence that this is not the case is afforded by a correspondent of the *Indian Field* newspaper, who writes that in the Bhamo district of Upper Burma he recently found a pair of leopard-cubs, one of which was black and the other of the ordinary spotted type. The tendency to blackness, or melanism, it may be noted, is most marked in hot, moist climates, like that of the district in question.

* * *

The World's Consumption of Ivory.

Our contemporary the *Zoologist* for May last contained a very interesting article on the supply of ivory from the Congo Free State, and of the world's annual consumption of this commodity. As regards the latter item, it appears that the total reaches the enormous figure, on an average, of 647,000 kilos., of which India and China take 144,000 kilos., the rest going to European markets. As regards the price of ivory, it may be mentioned that average tusks fetch from 24 to 25 francs per kilo., while the round and full tusks of from 6 to 8 centimetres in diameter realize as much as 30 francs per kilo. On the other hand, the price of inferior descriptions is only from 13 to 15 francs per kilo. A kilo, we may add, is equal to 2·204 lbs., that is to say practically 2¼ lbs.

* * *

The Classification of Reptiles.

The relationships of the different orders of living and extinct reptiles and the best mode of illustrating these in systematic classification are discussed by Mr. G. A. Boulenger, of the British (Natural History) Museum, in the August issue of the Zoological Society's *Proceedings*, at the end of a paper on the skeleton of a curious little reptile from the New Red Sandstone of Elgin. It has of late years become more and more evident that the remarkable extinct anomodonts of the equivalent of the New Red Sandstone in Africa and elsewhere differ very widely from all other reptiles, and approach mammals, of which they were undoubtedly the ancestors. For the first time this has been fully and definitely recognized in classification by Mr. Boulenger, who now divides reptiles into two brigades, the one including the anomodonts and their immediate relatives, and the other all the rest. The former brigade is termed Reptilia Theromora (= Theromorpha), or Mammal-like Reptiles, and the latter (from which birds took their origin) Reptilia Herpetomorpha, or Reptile-like Reptiles. In view of the fact that the latter combination is nothing less than tautology, the substitution of Reptilia Ornithomorpha (Bird-like Reptiles) may be suggested; and the two brigades would then be respectively known as the Theromorpha and the Ornithomorpha. There can be no doubt that Mr. Boulenger's classification is much superior to the one recently proposed by Professor H. F. Osborn, of New Haven, U.S.A.

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Corrigendum.

In the article on the Later History of the Horse in our August issue cuts 2 and 3 are unfortunately transposed.

CORRESPONDENCE.

Salmon in Fresh Water.

DR. THOMAS P. TUCKEY writes: That salmon never feed in fresh water I cannot credit, notwithstanding all the evidence adduced to the contrary. That no food has ever been found in the stomach of a salmon caught in fresh water I can well believe. I have the evidence of a man who fished the Blackwater in the South of Ireland ever since he could fish. This man died only a couple of years ago. He was a grown man before I was born, and I am a grandfather. This old man told me only the year before he died that he had never found anything in a salmon's stomach. Nay, he told me of a salmon which he once gaffed, supposing it to have been a fish which had broken away from some angler and which had been caught by the attached piece of line in a snag. To his astonishment, he found that the fish was stone-blind, and had only rudimentary eyes; it was, however, plump, and had all the appearance of a newly run fish. But I have instituted inquiries among the fishermen who take salmon in nets at the mouth of Fowey Harbour, and also among those who catch them in the tidal part of that river, and they have assured my informer that, though in the habit of repeatedly cleaning salmon after their capture, they have never found any food in such salmon. Now, it is quite incredible that salmon never feed either in the sea or during their sojourn in rivers, and it is much more probable that the same causes operate on the salmon in both their salt and fresh water habitats. We know how greedily they rise at the artificial fly, an object, to be sure, like nothing on earth or in the water, but still the salmon must liken this bait to some natural object, or they would not be so frequently caught by means of it. A salmon's sole idea of a salmon fly must be that it is something eatable, otherwise it would not open its mouth to get caught by the hook. But whatever objection may be brought forward about the artificial fly, what can one say about the worm, the minnow, and the shrimp? The worm the salmon has often seen floating by; the minnow and the shrimp swimming about in dozens, is it to be supposed that the fish will only take one or the other of the latter when they have a piece of gut attached to them. Such reasoning is truly a *reductio ad absurdum!* I daresay that salmon find it hard to support themselves in rivers, but Mr. Aflalo, in his "Natural History of the British Islands," states that "Salmon-roe is a deadly and illegal bait for the fish themselves." Salmon roe is, I know, a deadly bait for trout. I have not heard of its being used for salmon, but I am sure, if we are to judge by the rest of his work, that he knows what he is writing about.

The true solution of the matter, I think, will be found, when we know exactly what the salmon's usual food is. I should guess that in the sea it consists of jellyfish or some such soft gelatinous food, that its digestion is very rapid, and the undigested residue very trifling; and that in rivers the ova of fish may make one of its principal meals. I have also thought that the iridescent colours of the artificial fly may, to the salmon, similate the appearance of jellyfish, some of which when floating in the water display all manner of delicate and beautiful colours. This, of course, is mere conjecture, but I cannot fancy that a salmon swallows a mixture of gold twist and jay feathers for the fun of the thing, any more than I can believe the old fox-hunter when he asserted that Reynard liked being hunted.

REVIEWS OF BOOKS.

We have received from Messrs. Newton and Co., of Fleet Street, their new X-Ray catalogue, which includes information of a comprehensive kind regarding the "Apps-Newton" induction coils, the mercury breaks of improved patterns, and other apparatus for both experimental and practical work. Messrs. Newton announce the installation on their premises of an extremely useful switchboard equipment, by means of which customers can make themselves familiar with its use, and with the proper manipulation of their instruments.

The Northampton Institute and Technical Optics. In connection with the extremely useful classes in Technical Optics which have been developed at the Northampton Institute by Dr. Mullineux Walmsley, and which have received the warm support of the optical trade, a scholarship has been instituted by Messrs. Aitchison, to be called the "Aitchison Scholarship," which will defray the cost of the course of instruction of the student who wins it in the Institute's Day Courses of Technical Optics for two years, and will leave him a small balance in addition. The full course, as at present contemplated, extends over two years, and consists of lectures, laboratory work, drawing office work, tutorial classes, and workshop practice. Partial courses, extending over three years, have been arranged for those already engaged in some optical trade, and the scheme must command the warmest support of all interested in British Technical and Optical industries.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Coccidae.

With Notes on Collecting and Preserving.

By ALICE L. EMBLETON, B.Sc.

As greenhouse and garden pests, "scale insects" and "mealy bugs" are only too well known to the florist and horticulturist, for they abound in most climates, particularly in the tropics. They are easily distinguished from other insects, being strikingly different in many ways. The brown "currant scale" (*Lecanium coryli*) will serve as an example; or the brown "peach scale" (*Lecanium persicum*), both very serious enemies to the fruit-grower in this country. The description applies almost as well to the dreaded vine pest (*P. vitis*), which plays much havoc in wine-producing countries, and equally truthfully to the common brown scale on ferns and palms grown indoors (*Lecanium hemisphaericum*). These insects, and many others, are very similar in appearance, and also agree in being of considerable economic importance. A sketch of the scale found on the bark of currant bushes will suffice to illustrate the general nature of these creatures. In the adult stages they are firmly fixed to the host plant, and appear as small brown convex elevations, about one-eighth to one-sixth of an inch in length; the convex dorsal shell still bears some trace of a keel-like ridge running from back to front, sending out transverse branches connecting this keel at right angles to the limiting circumference. This description is of the female, for the male is winged, is less common, and has but a short life, so it may be left out of the present description. To return to the adult female of *Lecanium coryli*, it is found that under this hard, shining brown carapace she lives and breeds. In the winter her enveloping shell fits close to the surface to which it is attached, and it needs care to remove the creature uninjured; but in July one finds that the rounded mother-shell is nothing but a tent covering a heap of substance that looks like pink dust, but which is, in reality, the mass of eggs of the coccid. In a short time these eggs give rise to small yellow six-legged larvae, which move about restlessly all over the parent plant. It is interesting to note that the larvæ of most species seek to avoid light by creeping into crevices in the plant. At the end of about ten to fourteen days these active larvae settle down, and become fixed to the host plant by means of the long thread-like proboscis which is then buried deeply into the vegetable tissues; the nourishing sap being drawn up by this apparatus. The creatures have now assumed the characteristically "scale" mode of life, the white waxy powder which has until now coated them disappears, and gradually the mature condition is reached, and the cycle begins once more.

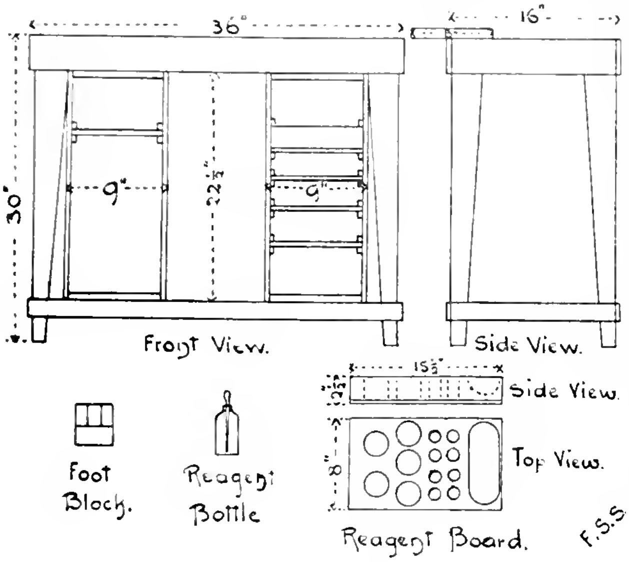
In different species there are, of course, minor dissimilarities, but in these characteristic features many species are alike. Some species, such as the currant brown *Lecanium*, produce at least three broods of young in the year.

Dactylopius destructor or *D. longifilis* will serve as an example of mealy bugs. They are also easily recognised, for they possess such distinctive characteristics that there is no fear of ambiguity in identification; this is more particularly the case with *D. longifilis*, which is marked by the long white posterior filaments in the female. The most common species in our greenhouses is *D. destructor*. Though they are such common and destructive insects, yet there is very little literature to be found on the subjects either of their life-history and habits, or morphology. However, it is known that they are very prolific, the female of *D. destructor* laying usually from 400 to 600 eggs at a brood. They are embedded in a white flocculose network of waxy threads, which cover the eggs and quite effectually protect them from attacks of other insects. The female feeds all the time she is depositing her eggs, and the end finds her nothing more than a little dry piece of dead skin, with the mass of eggs behind her. Before egg-laying commences she measures about 4mm. in length. In two or three weeks the young hatch out of the eggs, and after a day or two they leave the protection of the white flocculent covering and begin to wander about actively. They possess at this stage very conspicuous antennæ and legs, and are of a pale yellow colour. In one such brood there may be a dozen males; these soon separate themselves from the rest to construct a special little fluffy cocoon, from which, after two or three days, the winged male emerges. It is provided with three pairs of eyes, and lives but a very short time. *D. longifilis* is not oviparous like *D. destructor*, but is viviparous. It is a larger creature, but not so prolific, though it is as general a feeder as the allied species. These pests are very abundant in hothouses, where the artificial conditions of relatively constant temperature, moisture, and food supply give them a specially favourable environment, and their rate of production is consequently very rapid.

America suffers even more from the ravages of *Coccidae* than we do in this country; perhaps its most destructive insect is the San José, or Pernicious scale (*Aspidiotus perniciosus*). It is so widely disseminated, and has become so firmly established in the principal deciduous fruit regions of the United States, that its extermination is now, in most cases, out of the question; it is looked upon as a permanent factor to be regularly dealt with. There are, of course, the preventive and quarantine measures against introducing it into new regions on nursery stock, but once it has a foothold the only certain method of destroying it is the heroic measure of digging up and burning all infested trees. But orchards can be made profitable even if the scale be there, by controlling its spread by means of insecticides. The San José scale is found in Japan, being apparently of recent origin; probably it came on American fruit trees, chiefly from California, where it has been longest established, and where its ravages are most serious. But it is interesting to note that in Japan the San José has met its match, in the person of the little twice-stabbed ladybird beetle (*Chilocorus similis*). This beneficent little creature is the enemy of Japan's destructive scale, *Diaspis pentagona*, and, fortunately, it has taken just as readily to the introduced species, and very materially checks its increase. (*To be continued.*)

Microscopical Table.

A correspondent, writing over the initals J. Q. T. writes from Queensland Australia :—"At various times I have seen in your columns descriptions of work-tables for microscopy, and I venture, therefore, to send a description of how I made my own. The top of my table is made of half-inch pine, 30 inches by 10 inches, and is raised on four legs 30 inches from the ground. To make the table steady, I screwed on cross-pieces at both back and front, and at the sides, as illustrated. The lower front and back cross-pieces were 22½ inches from the upper cross-pieces, and upon these I screwed two narrow boxes 22½ inches in height, 10 inches deep, and 9 inches wide. To the front of these I attached doors by means of ½-inch hinges, and arranged a simple wire hook to fasten them, though a small lock or bolt would doubtless be preferable. The cupboards thus constructed contain as much as possible of my apparatus, excluding, of course, stock-bottles of reagents, etc., and are fitted with shelves in the following way. In the left-hand cupboard there is only one shelf for my objective jar (in this climate it is only safe to keep object-glasses in an air-tight jar with calcium



chloride), immersion oil, and purely optical accessories. In the space beneath I place the microscope itself in its case. In the right-hand cupboard the shelves are much more numerous, and are fitted so as to run in grooves. The upper shelf contains the reagents. For this I took a thick 2-inch board, pierced it with holes from one inch to three inches diameter, and then screwed it on top of a ½-inch board as shown in the sketch. At one end I gouged out a groove 8 inches long, 3 inches wide, and 1 inch deep to serve as a useful receptacle for section-lifters, brushes, etc., which should be conveniently at hand. It should be noted that the 2 inch holes in this shelf are the proper size to hold Grubler's 100 cc. reagent bottles, which I have found very useful. The bottles containing fixing, staining, clearing, etc., fluids are placed each in its proper hole, and on starting work the board is brought out and placed on the table. The shelf below is utilised to carry slips, cover-glasses, troughs for pond-life, etc. In the next shelf are kept note-books, pens and pencils, ink, paper, camera-lucida, and other accessories for recording observations; below this a turn-table, brushes, bottles of cement and varnish, etc., and so on. If work has to be left suddenly, a bell-jar is placed over the microscope to protect it from dust. To the front right-hand corner of the table is screwed a piece of 1 inch pine, 2 inches wide and 8 inches deep, so that 4 inches are on the table and 4 inches project; to this is clamped a small microtome. When using the table as a support for a photo-micrographic camera it was found to vibrate unpleasantly, and this I obviated by the following simple device. Eight pieces of 2-inch wood, each 4 inches square, were taken, and in four of these holes were drilled to take the feet of the table-legs, and they were then screwed to the top of the other four pieces of wood with pieces of rubber between (I made use of some old rubber tyre-tubes). All the bottles except those containing mounting media are fitted with corks and rubber-capped pipettes. To give the table a finished appearance I stained it with the following mixture, which was recommended some years ago in the American 'Journal of Applied Microscopy': (*a*) Copper sulphate, 25 parts; potassium chlorate, 25 parts; water, 200 parts. Dissolve the salts in hot water, apply hot, and give a second coat when the first is dry. Then apply (*b*) aniline oil, 12 parts; hydrochloric acid, 18 parts; water, 100 parts. This second solution must be applied cold. The power of the stain is much increased by subsequent washing with hot soap-suds and water. This stain gave a fine black, which is not affected even by nitric or sulphuric acid if they are quickly wiped off. My water supply consists of a large bottle (containing about 80 ozs.) placed on a shelf to the right of and above my table. From this comes a siphon of glass tube with rubber joints (rubber being perishable) ending in a fine jet a few inches above the table and closed by a clamp. The sink is a large enamelled bucket to receive waste liquids, and there is a tin box for waste paper, broken glass, etc."

Notes and Queries.

Reversal of Image in Using Beale's Camera Lucida.

A correspondent writes: "In making drawings of sections, when it is desired to sketch in the outlines by using the camera lucida and to put in the details freehand with direct vision, Beale's reflector, with its partial reversal of the image is notoriously awkward to work with, but its principal fault may be counteracted by the following procedure, so far as work with the lower powers is concerned. Put the slide upon the stage upside down, *i.e.*, with the cover-glass underneath, and focus through the thick glass slip, sketch the rough outlines, &c., of the section, then remove the reflector, reverse the slide so as to focus through the cover-glass as usual, and with a higher power if necessary, fill in the finer details freehand, using direct vision. Each part of the section will thus be found in its proper place in the outline sketch. Care must be taken not to knock the cover-glass sideways when removing it. If the stage aperture is small, the slip can be supported at the ends by pieces of glass." Another correspondent, Mr. C. H. Caffyn, suggests drawing on a sheet of paper placed on a piece of carbon or black-leaded paper, by which means the outlines will be found reversed when the paper is turned over, and can then be filled in without the use of the camera lucida.

Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.

The Face of the Sky for September.

By W. Shackleton, F.R.A.S.

The Sun.—On the 1st the Sun rises at 5.14, and sets at 6.46; on the 30th he rises at 6.0, and sets at 5.39. The equation of time is zero on the 1st.

Autumn commences at noon on the 23rd, when the Sun enters the sign of Libra.

There is a total eclipse of the Sun on the 9th, invisible in Europe, the shadow path lying entirely over the Pacific Ocean.

Sunspots, faculæ, and prominences are fairly numerous; at the time of writing, three groups of spots, as well as a considerable amount of faculæ, are visible.

The positions of the spots, &c., with respect to the equator and poles may be derived by employing the following table:—

Date.	Axis inclined from N. point.	Centre of disc, N of Sun's equator.
Sept. 1 ..	21° 19′ E.	7° 13′
„ 11 ..	23° 33′	7° 14′
„ 21 ..	25° 12′	7° 2′
Oct 1 ..	26° 11′ E.	6° 38′

The Moon:—

Date.	Phases.	H. M.
Sept. 3 ..	☾ Last Quarter	2 59 a.m
„ 9 ..	● New Moon	8 43 p.m.
„ 16 ..	☽ First Quarter	3 13 p m.
„ 24 ..	○ Full Moon	5 50 p.m.
Sept. 9 ..	Perigee	7 12 p.m.
„ 23 ..	Apogee	6 0 a.m.

Occultations.—The Moon passes through the Hyades about midnight of the 29th, when many of the stars are occulted; Aldebaran suffers occultation soon after sunrise on the morning of the 30th.

The Planets.—Mercury is in inferior conjunction with the Sun on the 16th, after which date he is a morning star in Leo.

Venus sets too soon after the Sun to be suitable for observation.

Mars is a morning star on the confines of Cancer and Leo, rising about 2.25 a.m. on the 15th.

Jupiter is the most conspicuous object in the sky, looking nearly due E. about 9 p.m. On the 15th he rises at 7.15 p.m., and is on the meridian at 2.16 a.m. The equatorial diameter of the planet on the 14th is 48″·4, whilst the polar diameter is 3″·1 smaller.

The planet is near the Moon on the evening of the 26th.

The configurations of the satellites, as seen in an inverting telescope at 12.30 a.m., are as follows:—

Day.	West. East.	Day.	West. East.
1	43 ○ 21	16	4321 ○
2	4231 ○	17	42 ○ 1 3●
3	4 ○ $^{1}_{2}$3	18	41 ○ 23
4	4 ○ 123	19	42 ⊙ 3
5	21 ○ 43	20	42 ○ 13
6	2 ○ 314	21	3$^{4}_{1}$ ○ 2
7	31 ○ 24	22	3 ○ 4$^{2}_{1}$
8	3 ○ 214	23	321 ○ 4
9	$^{2}_{3}$1 ○ 4	24	2 ○ 14 3●
10	●2 ○ $^{1}_{3}$4	25	1 ○ 234
11	●1 ○ 234	26	⊙1 ⊙2 ○ 34
12	21 ○ 43	27	2 ○ 134
13	2 ○ 413	28	$^{3}_{1}$ ○ 24
14	$^{4}_{3}$1 ○ 2	29	3 ○ 1$^{2}_{4}$
15	43 ○ $^{2}_{1}$	30	3214 ○

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Saturn is a very conspicuous object in the sky looking S. about 10 p.m.; he is on the meridian at 9.30 p.m. near the middle of the month, and although rather low down in the sky he well repays observation, for even with small instruments the planet is a beautiful object. The polar diameter of the ball is 17″·0, whilst the major and minor axes of the outer ring are 42″·5 and 11″·7 respectively; thus the ring plane is inclined to our line of vision at an angle of 16°, the northern surface being visible.

Uranus is on the meridian about 6 p.m. near the middle of the month, hence the best time for observation is immediately after sunset. He is practically stationary throughout the month, and is situated about 12 minutes W. of the star 4 Sagittarii.

Neptune does not rise until after midnight.

The Stars:—

At the beginning of the month, at 9 p.m., the following constellations are to be observed:—

Zenith . Lyra, Cygnus.

South . Aquila, Delphinus, Aquarius, Capricornus, Sagittarius; Serpens, Ophiuchus, and Scorpio to the S.W.

East . Andromeda, Pegasus, Pisces, and Aries; Pleiades on horizon.

West . Hercules, Corona, Boötes.

North . Ursa Major, Ursa Minor; N.E., Cassiopeia and Perseus; Auriga (*Capella*) low down.

Minima of Algol occur on the 6th at 9.53 p.m., 9th at 6.42 p.m., 26th at 11.36 p.m., and 29th at 8.25 p.m.

Telescopic Objects:—

Double Stars:—ζ Ursæ Majoris XIII.^{h} 20^{m}, N. 55° 26′, mags. 2, 4; separation 14″·4.

ζ Aquarii XXII.^{h} 23^{m}, S. 0°·35′, mags. 4, 4, separation 3″·2. Both components are yellowish.

β Cygni XIX.^{h} 27^{m}, N. 27° 45′, mags. 3, 5; separation 34″. The brighter component is yellow, the other blue; very easy double in small telescopes with a power of 20.

Cluster (M 11) in Aquila or Antinous. R.A. 18^{h} 46^{m} Dec. S. 6° 23′. Very pretty object for 3 or 4 inch telescope; it is an easily resolvable fan-shaped cluster, with an 8th magnitude star in apex and an open pair of the same magnitude just outside it.

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Snake Forms in the Constellations

And on Babylonian Boundary Stones.

By E. WALTER MAUNDER, F.R.A.S.

AMONGST the spoil brought by various explorers from Babylonia are a number of small sculptured stones, commonly known as boundary stones or landmarks. These are inscribed with texts in archaic Babylonian and Assyrian characters, and record the transfer of lands and estates, or grants and renewal of grants. But besides the inscriptions, most of them carry a number of figures sculptured in low relief. Some of these are certainly astronomical; others are probably so. There can be no mistake about such a figure as is seen in the middle of the second row of the stone shown in the accompanying photograph (see Fig. 1). The slab in question was one found at Susa, whither it had been taken from Babylonia, and contains the record of a land grant by Melishikhu, King of Babylon, B.C. 1200. The stone itself is in the Museum of the Louvre. The figure shows a "capricorn"—that is, a goat with the tail of a fish. On another stone, a representation of Sagittarius has been found, in which not only is the composite figure shown of the archer—half-man, half-horse, drawing his bow to the head of the arrow—but the archer has a wing, stretched back exactly like the flying cloak seen in the designs of our star atlases to-day. About composite figures of this definiteness there can be no mistake; they are obviously constellational in origin.

The case is a little different with such forms as the scorpion, the bull, the dog, or the eagle, since these forms are not specialised in the constellations; but their occurrence in such close connection with symbols manifestly stellar, renders it probable that they are of the same character. The argument with respect to the scorpion—a form continually seen—is stronger. Not only is the attitude of the scorpion always precisely that of the zodiacal animal, but a very fine boundary stone of the reign of Nebuchadnezzar I., King of Babylon, date about B.C. 1120, shows, as well as a scorpion, a vigorous composite figure which appears to have been formed by combining the symbols of the three neighbouring constellations, Aquila, Sagittarius, and Scorpio.

It is not surprising that the serpent should be conspicuous amongst these sculptured forms; it figures so largely in pagan mythology that its absence would be more surprising than its presence. Yet here the positions assigned to the various serpent forms are peculiar, and seem to me to bear a manifest relation to the positions occupied by the various snakes and dragons of the celestial sphere.

So far as I know, although it has often been noted that Draco is coiled symmetrically about the pole

Fig. 1.—Boundary-stone in the Louvre. Approximate date, B.C. 1200.
(From a Photograph by Messrs. W. A. Mansell.)

of the ecliptic, no astronomer has ever called attention to the very remarkable positions occupied by two great constellations, Hydra and Serpens in the primitive sphere. The reason of the oversight has been simply that astronomers have been led astray as to the date of the origin of the constellations by preconceived notions, and have entirely neglected the evidence which the stellar figures themselves supplied of their antiquity and place of origin. As I have had occasion to point out in this magazine before, the area in the southern heavens left untouched by any of the constellations handed down to us by Aratus, is clear proof that the

work of primitive constellation-making was carried out on an organised plan, and came to a conclusion at a definite epoch. The date of that conclusion was, roughly speaking, 2700 or 2800 B.C.; the place somewhere not far from N. Lat. 40°. For there, and there only, did the portion of the heavens covered by the traditional figures correspond precisely to that rising at some time or other in the year above the horizon of the place.

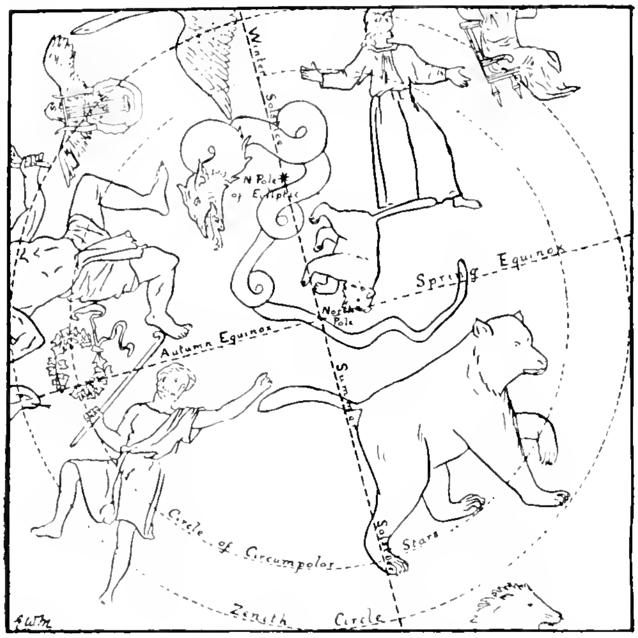


Fig. 2.—Circumpolar Constellations, B.C. 2085. Zenith of N. Lat. 40°.

If we take a precessional globe, move the pole back some 64° or 65° of precession, corresponding, say, to about 2700 B.C., and adjust the globe for N. Lat. 40° —in other words, set it to the time and place when the constellation figures were first defined—what do we find? First of all the Great Dragon (see Fig. 2) clearly is arranged so as to link together the north pole of the heavens and the north pole of the ecliptic. It is as nearly as possible symmetrical with regard to the two; it occupies the very crown of the heavens. With the single exception of the Lesser Bear which it almost surrounds, Draco is the only constellation that never sets.

Next Hydra. Here we have an arrangement even more striking. As Fig. 3 will show, Hydra at this time lay right along the equator, extending over about 105°, or seven hours of Right Ascension. Thirdly, Serpens. As Fig. 4 will show, the snake carried by Ophiuchus not only writhes itself for some distance along the equator, but struggles upwards, straight along the autumnal colure, reaching and marking the zenith by its head. It is scarcely conceivable that this threefold arrangement, which is not suggested by any natural grouping of the stars, should have been carried out as a matter of pure accident. It must have been intentional. For some reason or other—possibly for the simple one that a snake was the animal form that best lent itself to such a purpose—the equator, the colure, the zenith, and the poles were all marked out by these serpentine or draconic forms. Possibly in this striking but unmistakable relation we may find an explanation of the old myth that a total eclipse of either sun or moon was caused by a dragon; of the adoption of the Dragon's Tail as the sign of the nodes of the moon's orbit with the ecliptic; and of the term "draconic" or "draconitic" month for the period taken by the moon to pass from the ascending node round to the ascending node again. It may be noted that in Fig. 1 in the second row of figures, just succeeding the capricorn, there is a little house or altar surmounted by a symbol identical in form with the Dragon's Tail symbol, which we use to-day for the descending node.

But now let us turn to the boundary stones and see where and how the serpents are presented to us there. In Fig. 5, which is a photograph of No. 90,829 in the British Museum, and shows another boundary stone of The reign of Melishikhu, the dragon is seen on the very top of the stone, coiled in an attitude much like that of Draco of the sphere. In Fig. 1, we find the snake stretched out straight at the base of the stone like Hydra along the equator. In Fig. 6 (No. 90,840 in the British Museum), we have the snake bent sharply at right angles, lying partly, therefore, at the base of the sculptures, and partly up the side, in an attitude recalling that of Serpens along the equator and up the colure. The snake in Fig. 7 (No. 90,835 in the British Museum, of presumed date about 1100 B.C.), rises straight up the stone, and it is not certain whether we should identify it with Hydra or with Serpens. But the positions of the snakes or dragons in the first three instances are sufficiently striking as to suggest that some 1,500 years after the original designing of the constellations, and when both colure and equator had moved from their primitive positions, the tradition of the original purpose of these serpentine figures still remained.

There are three symbols, very clearly seen on the

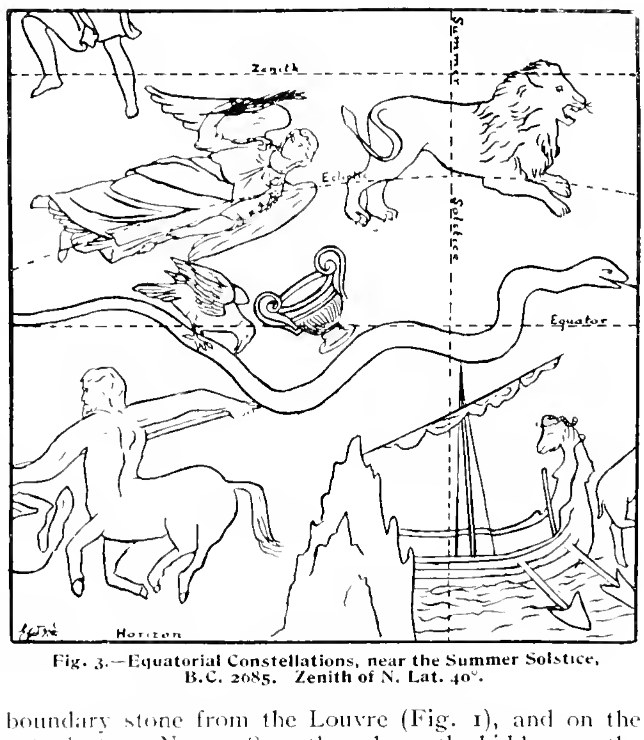


Fig. 3.—Equatorial Constellations, near the Summer Solstice, B.C. 2085. Zenith of N. Lat. 40°.

boundary stone from the Louvre (Fig. 1), and on the actual stone No. 90,840, though partly hidden on the photograph through the effect of foreshortening, which are of very considerable interest. They are present, though less distinctly seen, on the other two stones; indeed, with but one or two exceptions they are a feature of all stones of the class. These are a crescent moon "on its back," and two stars, usually of different forms. The first is an eight-rayed star, the second a

circle containing a four-rayed star. These we know, from actual inscriptions on some stones of the kind, to be the symbols of the patron deities of the first two months of the year; the first month being presided over by the moon-god, the second by a pair of deities, the "Heavenly Twins."

There is a special significance in both these symbols. The Accadian and Assyrian years were luni-solar, the months being actual lunations, and twelve months constituting a normal year. But since twelve months are eleven days short of a solar year, a thirteenth month must be intercalated about every third year, or the beginning of the year will quickly travel backwards amongst the seasons. The Mahomedan year, which consists of twelve lunar months, does this, and its fasts and feasts bear no relation to the seasons. But the Accadians evidently wished their year to conform as closely as possible to the solar year, and the method which they employed to secure this result was both simple and efficient. The first new moon of the year was recognised by the presence near it in the evening sky of a bright star, unquestionably at one time the star Capella. It might happen that on the first evening, when the thin crescent was perceived, it would be close to Capella, and the two objects would set together. Twelve lunar months later the new moon would be observed again, but these twelve months being eleven days short of a complete solar year the moon would be some 11° less advanced in longitude than it was on the former occasion. But since the moon's daily motion in longitude is about 13°, the moon and Capella would set nearly together on the following evening—the second evening of the month.

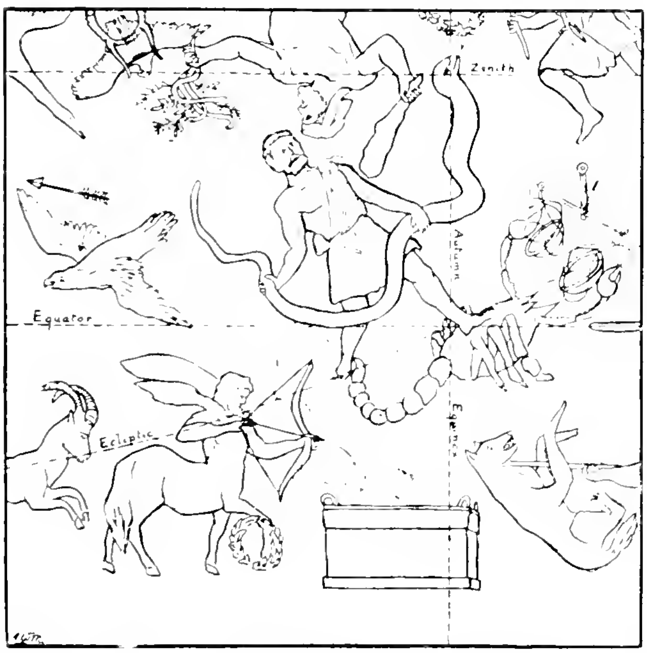


Fig. 4.—Equatorial Constellations, near the Autumn Equinox, B.C. 2685. Zenith of N. Lat. 40

At the end of another twelve months it would not be until the third evening of the month that Capella and the moon set together, and in a fourth year it would probably be on the fourth evening. But this, again, would involve that the two objects would set together on the first evening of the following month, which would, therefore, be the true first month of the year. In other words, the third year, that is to say, any year indicated by the setting together of the moon and Capella on the third evening of the month, would be a year thirteen months in length; other years would be of twelve months.

If Capella were observed setting with the moon at the beginning of the first month, would there be any bright star seen with it at the beginning of the second month? There would be two—Castor and Pollux—which would serve, should the evenings of the first month have been cloudy, to furnish just the same

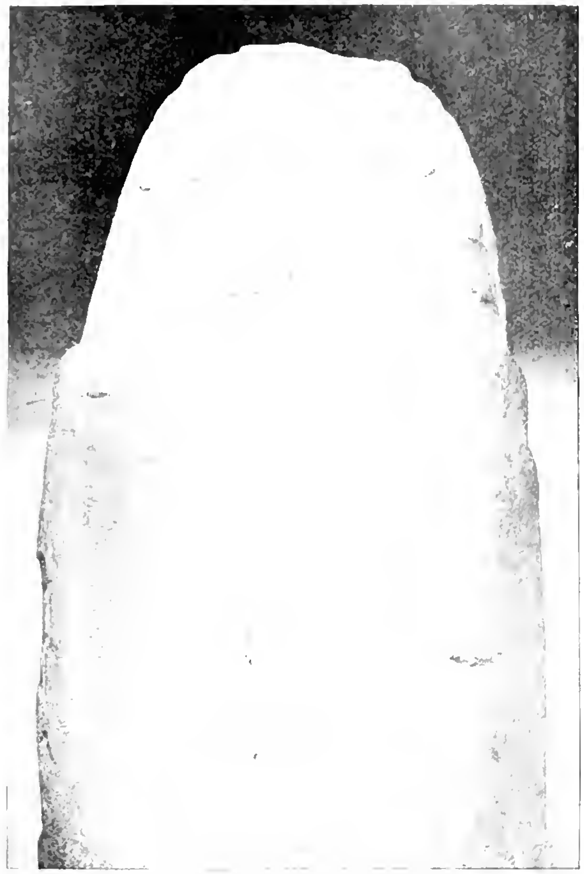


Fig. 5.—Boundary stone, No. 90,829, in the British Museum. Date, about 1200 B.C.
(From a Photograph by Messrs. W. A. Mansell.)

indication as to whether the year would be an ordinary one or an intercalary one, that Capella had given in the first month. There are no bright stars suitably placed to continue these indications for the succeeding months of the year.

This method by which the new moon was practically used as a pointer for determining the return of the sun to a definite constellation at the end of the solar year, is utterly unlike the methods which writers have supposed the ancient astronomers were accustomed to use. But we know from an existing inscription, that it was actually employed; it was eminently simple; it required no instruments or star maps; it may have been in use long before the constellations were mapped out; and though rough, it was perfectly efficient, and would give the mean length of the year with all the accuracy that was then required. It had one drawback, which the ancients could not have been expected to foresee. The effect of precession would be to throw the beginning of the year gradually later and later—roughly speaking, by a day in every seventy years, and the time no doubt came when it was noticed that the seasons no longer bore their traditional relation to the

months of the year. With Capella, as the star of the first month, the year would commence, on the average, with the spring equinox about 2000 B.C.; if Castor and Pollux were originally used for the first month of the year then the corresponding date would be 4000 B.C.

Now we can see the significance of this threefold symbol, so often seen on votive slabs and boundary stones—the moon "on its back" together with two stars. It is simply a picture of the sunset sky of the first evening of the first month of the year, some 6,000 years ago. The crescent is shown on her back, because then, on the first evening of the month nearest the spring equinox, she is more nearly in that attitude than at any other time throughout the year.

Fig. 6.—Boundary-stone, No. 90,840, in the British Museum. Date, about 1100 B.C.

(*From a Photograph by Messrs. W. A. Mansell.*)

I would suggest that these three figures, the simple representation of what all the primitive observers saw year after year through many centuries in the evening sky at the beginning of the first month, were handed down through long tradition as emphatically the symbols of the year; but that in process of time a certain change took place in the precise significance attached to them. At some time between 4000 B.C. and 2000 B.C., men must have recognised that the beginning of the year was falling too late. The obvious remedy would be to shift that beginning by a single month, where Capella would be ready precisely in the right position to act as index star. Whilst Capella was fulfilling this office it is probable that a separation was made in the three symbols. The crescent "on its back" would be still the appropriate sign for the first month of the year, but Castor and Pollux would now indicate the second. When the months were assigned to various deities the moon-god inevitably presided over the month of which the sign was the crescent; and the deities of the two great lights, Tammuz and Istar, would as naturally be associated with the pair of stars. Later still, Istar may have been identified rather

Fig. 7.—Boundary-stone in the British Museum.

(*From a Photograph by Messrs. W. A. Mansell.*)

with the planet Venus than with the moon, since the latter was already symbolised in the first month, so that Signor Schiaparelli's explanation of the three signs may hold quite good for latter times. That it did not hold good in earlier times we may infer from the well-known triumphal stele of Naram Sin, in which the twin stars are shown exactly similar in design, which could hardly have been the case if at that time they represented objects so dissimilar as the sun and the planet Venus.

[The photographs of boundary stones from the Louvre and the British Museum are reproduced by the kind permission of Messrs W. A. Mansell, of 405, Oxford Street, by whom they were taken].

III. The Influence of Fungi

For Bad on Other Forms of Life.

By George Massee, F.L.S.

Fungi are looked upon with a certain amount of justifiable suspicion by the majority of people, on account of their poisonous properties. Some kinds are undoubtedly very poisonous, but the dangers attendant on eating fungi have been much exaggerated. The percentage of edible fungi, compared with the whole number, excluding the microscopic forms, is much greater than in the flowering plants.

A very considerable number of the cases of fungus poisoning recorded annually are in reality not due to having eaten poisonous fungi, and may be explained as follows. In the country, when fungi are abundant, they are frequently not used sparingly, in the sense of a relish, but often constitute the greater portion, if not the only dish for a hearty meal. If a meal of this nature is accompanied or followed by the drinking of alcoholic liquor, more especially spirits, the fungi eaten coagulate and form an indigestible mass, which to say the least causes much discomfort, and may become serious. Strong tea acts in a similar manner to alcohol. An oyster supper followed by a copious supply of whisky would in most instances produce similar unpleasant results.

Nevertheless all such instances are recorded as cases of poisoning by fungi.

This is not the place to enter into an explanation of the differences between edible and poisonous fungi; it is, however, necessary to state that the old fables on the subject, such as the separable skin of the cap, or the blackening of a silver spoon when brought into contact with the cooked fungus, are absolutely unreliable.

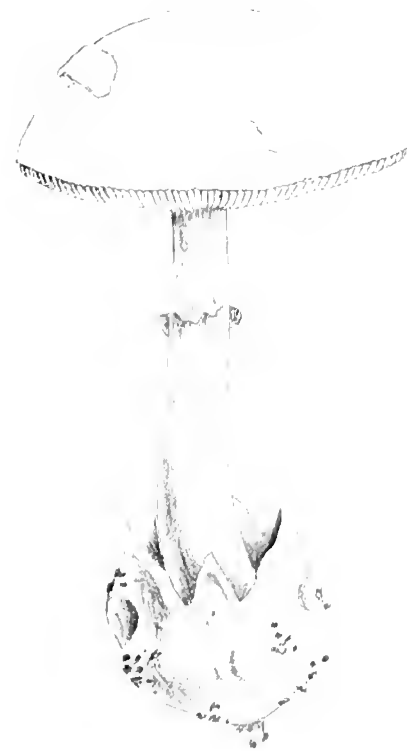
Above ninety per cent. of the cases of poisoning by fungi, both in Europe and North America, is due to partaking of one particular kind of fungus called the "Death cup" (*Agaricus phalloides*). The popular name is derived from the presence of a loose cup-like sheath surrounding the base of the stem.

The presence of a cup at the base of the stem is not, however, the hall-mark of all poisonous fungi; in fact, some among the best known of edible fungi have a similar cup, and it is the sum-total of characters presented by the "Death cup" that enables it to be recognised with certainty.

The "Death cup" is very abundant in woods in this country, but does not grow in open pastures like the common mushroom. When full-grown, the cap is slightly convex, smooth, and usually of a very pale primrose colour; the gills remain permanently white: the stem is from four to five inches in length, white, and bearing a loose white collar some little distance from the top; the base is surrounded by a loose cup-like sheath having a ragged edge.

Lack of space forbids entering into a detailed account of the numerous diseases caused to members of the animal kingdom by fungi—"Thrush" (*Oidium albicans*), appearing in the mouths of infants; "ringworm" (*Achorion Schoenleinii*), a disease which passes from man to animals; "Muscardine" (*Botrytis bassiana*) proves very destructive to silkworms. Mention has already been made of the diseases of other insects caused by fungi.

In speaking of fungi beneficial to other forms of life, it was stated that we benefited to the extent of hundreds of millions of pounds sterling annually through work done by fungi. On the other hand, it is equally true that we annually lose at least an equal amount, due to the injury caused by parasitic fungi. In support of this statement, which, perhaps, might be considered as improbable, it may be well to give some official statements. The Prussian Statistics Bureau announced a loss of £20,628,147 on wheat,



The "Death-cup" Fungus (*Agaricus phalloides*). **Natural size.**

rye, and oats grown in Prussia, caused by grain rust during the year 1891. Wheat rust caused a loss of £2,500,000 on the wheat harvest of 1890-91 in Australia. In the year-book of the United States Department of Agriculture for 1898 the loss of cultivated crops caused by fungi for that year is estimated at £40,000,000. A fungus disease called peach leaf-curl, which proves very destructive to peach trees, does injury to the extent of £600,000 annually in the United States. No official statements as to the amount of injury done by fungi to cultivated crops are issued in this country, but it is quite certain that we suffer as much in this respect as other countries. English cucumber growers suffered a loss of at least £20,000 during the year 1901, caused by the ravages of a microscopic fungus parasite.

The question naturally suggested by the above statements is, Can nothing be done to prevent, or at least to reduce, such enormous losses? In answer it may be

stated that at the present day provisions are made in almost every civilised country for studying fungus diseases, and for imparting practical information on the subject to farmers and horticulturists. In this country the Board of Agriculture is the headquarters in this matter, aided by various colleges and societies.

Symbiosis or mutualism are terms expressing a condition of things where parasite and host mutually benefit by their union. Lichens are the most pronounced examples of this condition of things, and even here the combination retains many of the characteristics of a more pronounced type of parasitism, where the plant attacked suffers from every point of view without any compensating factor. For instance, the algal and fungal constituents of a lichen each loses its own individuality, and is incapable of performing those functions which are natural to it as a free and independent entity.

The Hawthorn Cluster-cup Fungus. (1) The first condition parasitic on a Juniper branch (natural size); (2) the second condition growing on a living pear leaf (natural size).

In many other instances where a parasitic fungus attacks a particular host plant, the latter is not killed, but on the other hand the part attacked, which is often sharply localised and modified, continues to grow from year to year. This is very clearly seen in the dense tufts of branches popularly known as "witches' brooms" or "birds' nests," so common on many of our forest and fruit trees.

Such developments, which are frequently of large size and very conspicuous, present marked differences in structure and habit to the normal portion of the tree on which they are growing. For instance, the branches of "witches' brooms" always grow erect, the leaves are feebly developed and almost destitute of chlorophyll, and are hence incapable of assimilating food; finally, such portions never bear flowers. Now, from the above statement, it will have been gathered that such combinations of fungus and host plant are incapable of furnishing themselves with food, and in reality lead in turn a parasitic life on the normal part of the tree of which they form a portion.

It may, perhaps, be well to state that not every "bird's nest" seen in trees is caused by a fungus. For example, the dense tufts so common in many birch trees are caused by a very minute mite.

Allusion has already been made to the fact that many fungi assume a very different appearance both in form, size, and colour, during different periods of their development. These contrasts are in many instances so pronounced that the various phases of one and the same fungus were at one time considered as entities or distinct species, and allotted positions in the classification of fungi widely separated from each other.

Loose smut of oats, *Ustilago avenae*. (1) Ear of oats infected (natural size); (2) spores of the fungus highly magnified; (3) spores germinating and producing minute secondary spores (highly magnified).

Our knowledge at the present day that certain forms are but links in the chain of one species depends on what are termed pure cultures. This means that one form or condition of a fungus, grown under conditions which prevent the possibility of contamination from outside sources, eventually produces the second condition; while this, in turn, again gives origin to the first condition.

As an illustration of a fungus appearing under two remarkably different forms, and growing on different plants during certain stages of its life-cycle, may be mentioned the destructive parasite popularly known as hawthorn cluster-cups. The first or spring condition, called *Gymnosporangium clavariaforme*, grows on the common juniper tree, where it causes the infected branches to assume a swollen or gouty appearance. During the month of May these swollen portions become covered with dull orange-coloured, gelatinous, finger-like bodies about half an inch long. When examined under the microscope, these orange gelatinous masses are seen to consist entirely of a mass of

spores, each spore being divided by a cross-wall into two equal portions, and supported on a very long slender stalk. The mycelium of this condition of the fungus is perennial; that is, it remains living in the infected juniper branch from year to year; consequently, when a branch is once infected, the disease continues to spread, the swelling continues to increase in size, and a crop of spores is formed every spring. If the orange masses of spores are carefully observed they will be seen eventually to become covered with a delicate whitish bloom, resembling in appearance the bloom on a plum or a grape. Examination under the microscope shows that this apparent bloom consists in reality of a mass of exceedingly minute spores, or, as they are usually called, secondary-spores, produced by the much larger previously formed orange spores.

These secondary-spores, which are produced in enormous quantities, become free when mature, and are distributed by wind, birds, insects, &c., and those that happen to alight on the moist surface of young leaves of pear trees, or on the young shoots, leaves, or fruit of the hawthorn, germinate and enter the tissues of the living plant, and in course of time produce the second form of fruit, at one time considered as an independent fungus, and called *Roestelia*. The spores of this form are in turn dispersed by wind, &c., and those that alight on a juniper branch give origin eventually to the form of fruit found only on juniper.

The feature to remember in the above account is the fact that the spores produced by the form of the fungus growing on juniper cannot directly infect a juniper again, but can only infect pear or hawthorn; on the other hand the spores produced on pear or hawthorn cannot directly infect either of these plants, but only a juniper plant. The spores cannot infect any other plant except the three mentioned.

The very injurious rust of wheat, *Puccinia graminis*, which abounds wherever this cereal is cultivated, is a fungus having four different forms or phases included in its life-cycle. Two of these appear in the spring on the young leaves of the common barberry, and less frequently also on the fruit of this shrub. The first condition to appear on the leaves, under the form of minute, inconspicuous yellowish clusters of pimples, are the spermogonia, structures of unknown functions, and by some considered as aborted male organs. These are quickly followed on the opposite side of the leaf by clusters of minute, cup-shaped bodies with notched edges, and filled with myriads of very minute golden spores. The last mentioned stage of the fungus was once considered to be an independent plant, and was named *Aecidium berberidis*. It is popularly known as "cluster-cups," and is a very beautiful object when examined with a pocket-lens, or under a low power of the microscope. The spores produced in the cups are scattered by wind or carried by various insects or animals, and those that happen to alight on the young leaves of wheat soon germinate and enter the tissues of the wheat leaf, and after the space of a few days rusty-orange streaks appear bursting through to the surface of the leaf. These rusty streaks consist of masses of spores belonging to the third condition of the fungus, once called *Uredo linearis*. The spores of this form are produced in immense numbers and in rapid succession throughout the summer months, and, being scattered by the various agents enumerated above, it can be readily understood how quickly an epidemic of rust can spread when a few wheat plants in a field have once been infected.

During the autumn when the wheat is approaching maturity, the development of *Uredo* spores ceases, and a fourth form of spore, the last in the sequence of development, appears on the leaves of the wheat plant. This is the *Puccinia* stage. These spores remain in a dormant condition until the following spring, when they germinate and produce very minute secondary-spores which, when placed on a barberry leaf, give origin again to the spermogonia and "cluster-cup" conditions, and the cycle of development commences anew.

The "Smuts" and "Bunts" are also very destructive to cereals, forming a dense mass of black soot-like spores in the ears. Some species infesting wheat have a very unpleasant odour resembling decaying fish when rubbed between the fingers. The life-history of the Smuts (*Ustilago*) is peculiar.

The minute black spores are scattered by wind, and remain in the soil until the following spring, when they germinate, and the germ-tubes enter the tissues

The conidial or first stage of a fungus called *Sclerotinia fructigena*, very common on the fruit of the apple, pear, plum, cherry, &c. It causes the fruit to become dry and "mummified" (natural size).

of seedling cereals. The fungus grows in the tissues of the host-plant without doing any apparent injury until the ear is formed, when the fungus develops in the position normally occupied by the grain, and in due time its mass of black, powdery spores bursts through the tissues of its host-plant. In all cereals except maize the fungus can only infect the plant during the seedling stage. When a month old the fungus mycelium can no longer enter the tissues. Space prevents more than a passing allusion to the numerous diseases caused by fungi to forest and fruit trees. Larch trees, especially when grown in low damp districts, suffer severely from a small and very beautiful cup-shaped fungus, orange inside, snow-white and minutely woolly on the outside. Fruit trees, more especially apple, are too often killed by a fungus which destroys the bark and produces a cankered appearance, finally killing the branch attacked.

Neither are fruits exempt, the numerous blotches and rotten patches on ripe fruit being in most instances attributable to fungi.

Astronomy in the Old Testament.

By Miss M. A. Orr.

The Jews were forbidden to study and forecast the movements of the heavenly bodies, lest they should be led away into star worship and star divination. So says the Talmud. Yet some knowledge of astronomy is necessary to a nation, and especially to her priests; for only by observation of the heavenly bodies can the dates of festivals be accurately fixed. How far did this knowledge extend with the Jews?

Professor Schiaparelli, who has written learnedly and sympathetically on ancient Greek astronomy, now essays to answer this question, by studying the text of the Old Testament, and comparing it with the best translations and commentaries. The data are scanty, and unfortunately just where we might expect to find light—namely in the ancient Jewish calendar—we are in the dark. The month was evidently lunar, from its Hebrew name, and from the frequent mention of festivals of the new moon; the year was as clearly solar, since the three great yearly religious festivals were all connected with the seasons. But a solar year does not contain a whole number of lunar months, and the problem of bringing the two into accord has taxed the skill, and tested the knowledge, of primitive astronomers of all nations. We cannot be sure how the Jews solved the problem. They counted twelve months in their year, and no mention is made of extra days or intercalated months. Some such device, however, there must have been. Some writers assume that astronomical observations were made, which would have been the only exact guide. Professor Schiaparelli thinks, with some others, that a thirteenth month was added whenever it was apparent that the crops would not otherwise be ripe in time for the offering of first-fruits, which was made on the fifteenth day of the 1st month. In this way direct terrestrial observations of the seasons would be used to correct a calendar founded on celestial phenomena. The Jubilee period of 49 solar years is almost exactly equal to 606 lunations, and this would have given a useful cycle: but there is no reason to think that it was used for this purpose.

In connection with the custom of reckoning the day from evening to evening, derived perhaps from the method of beginning the month with the first appearance of the crescent moon, Schiaparelli suggests an explanation of the curious phrase "between the two evenings." (See marginal translation at Exodus xii. 6 and xxx. 8.) The evening, he says, was divided into two parts, the first beginning at sunset when it was still light enough to work, the second at the moment when a crescent moon would be visible, and ending when it had become quite dark and all stars were visible. The second evening would begin, on an average, half an hour after sunset, and an hour before dark. This was the beginning of the new day, and it was then that Aaron lighted the lamps and burned incense.

How were night and day divided? There is no word for hour in Hebrew, but only in the dialects which took its place in Palestine after the Exile. The word in the book of Daniel is Aramaic, and the expression "that same hour" means merely "immediately." Much has been written about the so-called dial of Ahaz. The fact is, as Schiaparelli points out, that the word which in our Authorised Version is given first as "degrees" and then as "sun-dial" is in the Hebrew the same, and means literally "steps." A glance at the marginal notes will show that the rendering is a hypothesis of the translators. Hezekiah, living about 700 B.C., may have possessed a sun-dial, brought from Babylon or elsewhere, but there is no internal evidence to prove that he had; and it seems quite as likely that the passage: "Behold, I will bring again the shadow on the steps, which is gone down on the steps of Ahaz, ten steps backward" refers to a flight of palace steps which the sick king could see from his bed, and that he marked the lapse of time by the creeping of the shadow from step to step. If dials were used, there would surely be some mention of divisions of the day more exact than "in the heat of the day," "early in the morning," &c.

The Hebrew week, with its seventh sacred day, Schiaparelli thinks had no connection with the Babylonian unlucky seventh day, since that was bound up with the lunar month, while the former was an independent period.

A few stars and constellations are mentioned in the Old Testament, but it is sometimes difficult to know which are meant. Most commentators agree that the Kesil and Kimah of Job and Amos are Orion and the Pleiades, but there is a curious passage in Isaiah: "The stars of heaven and the Orions (Kesilim) thereof," which the Authorised Version renders "the constellations thereof," and the Vulgate "the glory of them." Probably Orion is here put for any constellation, being bright and well known. "The sweet influences of the Pleiades" is a free rendering of a puzzling expression. No one knows what was really meant by the "chains" or "delights" of the Pleiades, for the literal meaning is one of these. Some have thought it an allusion to the time of year in which the Pleiades were visible; Maury saw in it a reference to Alcyone as the central sun of the universe! To the present writer it seems that in this passage Job is challenged to form or break up the constellations which had been set in heaven by an immutable Divine decree: "Canst thou bind the Pleiades into a cluster, or scatter apart the stars of Orion?"

The Authorised Version translation of Arcturus in the eighth and thirty-eighth chapters of Job is open to question. It is more often thought to be Ursa Major; but Professor Schiaparelli gives weighty reasons, too many to detail here, for believing it to be Aldebaran, and the "sons of Aldebaran" the Hyades.

Less convincing, but ingenious, is the suggested explanation of Job xxxvii., 9: "Out of the Inner Chambers comes the south wind, from Mezarim the cold." "The Chambers of the South" are also mentioned in the ninth chapter of Job among constellations, and Professor Schiaparelli thinks that they were a Jewish constellation, containing the brilliant stars of Argo and Centaur, the inner chambers (= penetralia) of a house being where jewels and precious things are kept. Mezarim should be a northern constellation to complete the antithesis: correct the reading to Mizrajim, the Threshing Flails, and this aptly describes the forms of Ursa Major and Minor. The Septuagint translates Mezarim as Arcturus, but means (says Grotius) Arctos—*i.e.*, Ursa Major. So old, then is Shelley's mistake:—

"Daisies, those pearled Arcturi of the earth,
"The constellated flower that never sets."

* "L'Astronomia nell' Antico Testamento, G. Schiaparelli. (Milan: Hoepli.)

Of the planets, there can be little doubt that Venus is named in the splendid apostrophe: "How art thou fallen from heaven, O Helél, Son of the morning!" It has been thought that Venus and Jupiter were meant by the Gad and Meni ("that troop" and "that number") of Isaiah lxv., 2, but this is doubtful. If Kaivan, rather than Chiun, is the correct reading of Amos v., 26, Saturn is here intended, for that was his name among the ancient Arabs and Syrians. The passage would read: "Ye have taken Sakkuth your king, and Saturn, the star of your God, images which ye have made for yourselves."

The only other name in the Bible which is certainly connected with stars is that of Mazzaroth. "Canst thou bring forth Mazzaroth in his season?" is asked of Job, immediately after the mention of Orion and the Pleiades quoted above. A name so nearly alike that it can hardly fail to be the same thing occurs in one other place. In the reform of Josiah, the burning of incense to "Baal, to the Sun, and to the Moon, and to Mazzaloth, and to all the host of heaven," was abolished. For etymological and other reasons, Mazzaroth, or Mazzaloth, has been variously translated as Lucifer, Sirius, Ursa Major, the northern stars generally, Corona Borealis, Orion's belt, the constellations of the Zodiac, the stations of the Moon, the planets. Professor Schiaparelli, without venturing to decide absolutely, favours the first, chiefly for the following reasons:—

(1) A plural noun is used with a singular pronoun, suggesting the dual nature of Venus as morning and evening star.

(2) "In his season" indicates a periodical appearance and disappearance.

(3) The position of the name in the sentence, coming after Sun and Moon, but before all the host of heaven, suggests a star inferior only to Sun and Moon in brightness.

We may, however, be permitted to suggest that Mazzaroth was perhaps superior to the host of heaven in importance, not in brightness; and, if so, this argument, as well as the two others, would apply equally well to the constellations of the Zodiac. They are plural, though the Zodiac is singular; and their chief feature is periodical re-appearance.

But Professor Schiaparelli reminds us also of the three constantly recurring symbols on Babylonian monuments, which we know represent Sin, Samas, and Istar that is, Sun, Moon, and Venus. The "host of heaven," when it means something more than simply the stars in general, he regards as all the planetary and starry deities of the Babylonian Pantheon, the "spirits of heaven."

The attempt to formulate a Hebrew cosmogony does not appear to us altogether successful. It is difficult to accept the view that, because Job speaks poetically of the sky as "strong, and as a molten looking-glass," while in a Psalm it is likened to a curtain, therefore the Hebrews recognised two heavens, one above the other, the higher containing the stars; nor does it seem like serious criticism to try to locate the "treasuries" of hail, snow, and wind.

The truth is that the ancient Hebrews felt no intellectual need, as did the Greeks, to construct world schemes in order to explain natural phenomena. The universe was to them, as Professor Schiaparelli himself observes, simply the marvellous and inscrutable manifestation of one supreme Power. It will doubtless be a surprise to some to find that a whole book can be filled with the astronomy of the Old Testament.

Photography.

Pure and Applied.

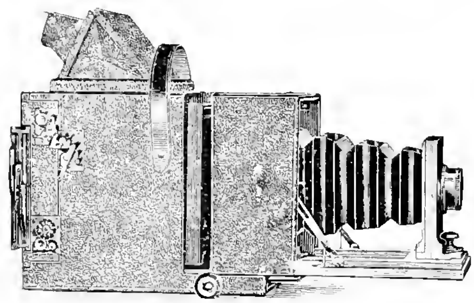
By Chapman Jones, F.I.C., F.C.S., &c.

Measuring Apparatus.—Photographic operations and apparatus for their investigation are far from perfect from a scientific point of view. There are no instruments, so far, even if there are methods, that can fitly be described as "standard," so that every investigator who seriously devotes himself to the subject has first to examine experimental methods and then, generally, to design the apparatus that he considers will prove most suitable. There are a few fundamental matters that too often do not receive the consideration that they demand by reason of the general want of experience. It is obvious that in all experimental methods it is waste of trouble to eliminate a very small error while a large error remains. It is very difficult to enforce this principle even in the most obvious cases, as, for example, in the common case of weighing a measured quantity of liquid. Here, if the smallest difference in measurement is equal to a drop (say ·02 gram), it is useless to refine the method of weighing beyond about a tenth of its weight (say ·002). One may admit the correctness of this principle, and yet easily fall into the error of neglecting it, especially when the larger source of error is not particularly obvious. It is sometimes easier to see the mote than the beam. It seems to me possible that Messrs. C. E. K. Mees and S. E. Sheppard have made this kind of mistake in designing the apparatus described in the next paragraph, and this suggestion receives a certain amount of confirmation by the fact that they refer to my opacity meter as an opacity balance, and to the opacity balance that I subsequently described as an "improved form" of the earlier instrument. Neither of these two instruments is an improved form of the other, they are distinct instruments. The *meter* measures the opacity by comparing the light that it transmits with the original light, and the measurement is absolute in the sense that the estimation depends only on the correct adjustment of the meter, the observer's experimental ability, and the opacity measured. The *balance* cannot do this at all. It merely serves to compare similar opacities on the same plate, as, for example, in evaluating the results of an experiment by means of a light-scale of known value produced on the same plate. The meter, of course, can do this also, but the balance serves this one purpose better, being more convenient and more accurate for it than the meter. The balance will not even serve to estimate opacities by comparing them with a standard opacity scale, such as the circular graduated screen (incorrectly called a sensitometer) first produced by Mr. Warnerke and now made by Messrs. Sanger Shepherd and Co., because in the opacity balance the light transmitted that is scattered is lost. The proportion of this scattered light is very large, and I have shown it to vary between wide limits according to the nature of the deposit in the film, and to vary even in different opacities in the same plate.

The Apparatus used by Messrs. Mees and Sheppard.—In the current number (July) of the *Journal of the Royal Photographic Society*, Messrs. C. E. K. Mees and S. E. Sheppard describe the apparatus they use in their photographic investigations, and which they intend for use in "scientific photochemical research and plate-making and testing." A machine for coating small quantities of plates for experimental purposes has a

bed of plate glass supported on levelling screws, along which is drawn at constant speed a piece of glass covered with velvet on its under side and carrying the plates to be coated. The trough that holds the emulsion is made of platinoid, it is surrounded with a large hot-water bath, and to pass the emulsion to the plates it has a slit below, that is made with great accuracy and adjustable like a spectroscope slit. The trough is 7 c.m. high and 1 c.m. wide. I should have thought that the alteration in level of the emulsion during the coating would have caused a variation in the thickness of the layer deposited, but there appears to be no mention of this. As a constant light, the authors employ a small area screened off from an acetylene flame. To graduate the light, a rotating disc with apertures in it of the ordinary kind is used, but it was made with special accuracy and calibrated before use. Much convenience and advantage results from enclosing the disc in a case with an opening and grooves on one side to take the slide that contains the plate, and a camera-like extension on the other containing a flap-shutter for starting and closing the exposure, cells for colour screens, and a diaphragm. It need not be used in a dark room. For developing the plates, which are one inch or an inch and a half wide, a thermostat containing about 10 gallons of water is used, with a stirrer, and a regulator of the ordinary Reichart type, the developer being contained in vertical glass tubes. During development the plates are rotated in the tubes, being suspended from vertical spindles for this purpose. The authors appear to find that this movement is better than a rocking movement with the plate horizontal, but still not perfect. I should have thought that this method would give a difference according to whether the end of the plate with the longest exposure was placed uppermost or otherwise, because at this end there must be the greatest change in the developer, and the vertical mixing effect produced by the regular rotation of the plate on a vertical axis in a tubular vessel must surely be very small. For measuring the opacities the authors use a Hufner spectro-photometer, but with several modifications to fit it for this particular work. I may be mistaken, but I cannot find from the description that the difficulty of the scattered light is met in any way. It is easy to measure something, and with considerable accuracy, but if the something measured is indefinite the results cannot be very valuable. It is better to sacrifice a little accuracy if necessary for the sake of knowing exactly what is being dealt with. Perhaps the authors have taken more precautions than are obvious for their description. Regarding the apparatus as a whole, it appears to me that it presents many points of advantage that future workers will profit by, but I am convinced that there are many matters that need investigation before the results obtained in working with it can be accepted without qualification. I have sought only to give a general idea of the apparatus; those interested will, of course, refer to the original paper.

A Naturalist's Camera.—The possibility of getting good typical photographs of living things has been amply demonstrated during the last few years, and many photographers have devoted themselves to this kind of work. That results of the first quality can be obtained with an ordinary camera when supplemented by home-made contrivances, has been shown by the brothers Kearton; but the methods which they follow are possible for only a very few and appreciated by still fewer. Hence the demand for special facilities. One of the most recent cameras that has been devised to meet this demand is the "Birdland" camera designed by Mr. Oliver G. Pike and constructed by Messrs. Sanders and Crowhurst. It is a hand camera, for Mr. Pike's method of work is to follow the bird he wishes to photograph, focussing it meanwhile with one hand upon the full-size reflex finder, and to release the shutter with the other hand as soon as the bird is in the desired position. The well-known Anschutz focal plane shutter is made to form a part of the camera, and an especial part of the apparatus is the connection of this with the mirror of the finder so that when the release is actuated the mirror moves out of the way immediately before the opening in the blind passes across the plate. The whole movement follows so quickly on the touch of the trigger that there is no sensible interval, nor is there any jar or noticeable noise. The camera has many conveniences, the chief of which are a mirror in the finder hood, so that the image can be observed and focussed with the camera level with the eye, and the possibility of opening the front and drawing the lens forward, as shown in the figure, to allow of one combination of the doublet, or a lens of greater focal length, being used. The sensi-



tive material is carried in double backs, changing boxes, or roller slides. A camera of this kind is, of course, eminently suitable for almost any work in which a moving object has to be photographed at a critical moment, and that this particular instrument serves the purpose well is abundantly demonstrated by the photographs obtained by its aid by Mr. Pike himself and by Mr. F. Martin Duncan. A small selection of these is reproduced in the pamphlet describing the camera, which can be obtained on application to the makers.

The Scintilloscope.

One of the small defects of the cleverly-devised instruments for displaying the scintillations which are produced by the bombardment of radium is, that the speck of radium is placed on a tiny pointer, which is between the spectator's eye and the screen of pitchblende or other material that is bombarded. Consequently, the pointer partly obscures the effects. In a little instrument sent to us, and called Glew's "Scintilloscope," the defect is remedied in an ingenious way. The instrument is in two parts, one part of which is the usual magnifying lens. The other part, detachable, is a double screen. The upper part of the screen is a thin plate of pitchblende polonium, or thorium, all of which are extremely sensitive to the impact of the "alpha" rays that proceed from a radio-active material.

The lower or underneath part of the screen consists of a plate coated with some such material. The alpha rays strike upward, and produce scintillations of great brilliancy on the pitchblende or polonium above. The instrument is fitted with one, two, or three screens, and the difference in the effects produced is very interesting.

Sunspot Variation in Latitude.

By E. Walter Maunder, F.R.A.S.

In his letter, under the above title, in the August number of this journal Dr. Lockyer complains that Father Cortie and myself have misunderstood the meaning of the term "spot-activity track" which he has originated. I think this complaint has no justification in fact. Certainly, for myself, I did not suppose that he intended the term to apply to the proper motion of any individual spot, but it is abundantly clear that he did intend to intimate by it that the spots were gathered together in certain districts or regions, separated from each other by broad barren intervals, and that these districts, rich in spots, moved continuously downwards towards the equator; so that the entire "eleven-year period" was the summation of three, four, or five separate and distinct shorter cycles of activity. Dr. Lockyer himself applies the term "zone" to these districts; he has drawn them in his diagrams as distinct, widely separated, areas, each one moving continuously towards the equator; and his descriptions of them perfectly accord with his diagrams. He writes:—

> "From sunspot minimum to minimum there are three, but generally four distinct 'spot-activity tracks,' or loci of movements of the centres of action of spot disturbance." (*Proc. R. S.*, Vol. LXXIII., p. 147.)

Again:—

> "These 'spot-activity tracks' have possibly a terrestrial equivalent in the variations from year to year of the positions of the 'Zugstrassen' or cyclone tracks of Koppen, it having been found that cyclones in general, which move in the direction of the great mass of air carried by primary currents, have a strong tendency to pursue somewhat the same tracks according to the place of origin." (*Ibid*, p. 147.)

Yet again:—

> "Spoerer's Law of Spot Zones is only approximately true, and gives only a very general idea of sunspot circulation. Spoerer's curves are the integrated result of two, three, and sometimes four 'spot-activity track' curves, each of the latter falling nearly continuously in latitude." (*Ibid*, p. 152.)

Again, speaking at the Royal Astronomical Society, on 1903, May 8, Dr. Lockyer said:—

> "The general idea about the spot zones is that spots begin in a zone in high latitudes (about $\pm 30°$ to $\pm 35°$), and this zone gradually approaches the equator until the spots vanish about latitude $\pm 5°$, the new cycle commencing again in $\pm 35°$. Now a glance at this diagram* shows that this is far from correct, because sometimes there are two, and occasionally three spot zones in existence in one hemisphere at one moment. Take the case of the year 1893, when you have three zones. The curves of Spoerer are, therefore, very misleading, for by taking the mean position of several spot zones you arrive at a latitude in which spots may not exist at all." (*Observatory*, 1903, June, p. 236.)

*The diagram of my paper communicated to the Society at this meeting, 1903, May 8

It was because these descriptions answered to nothing on the sun that I communicated a "Note on the Distribution of Sunspots in Heliographic Latitude" to the Royal Astronomical Society at its last meeting. I explained therein the nature of the mistake which Dr. Lockyer had made with regard to the maxima on which he based his paper, and that his method of joining them up so as to show apparent lines of drift was not only purely arbitrary, but was often against very distinct and positive evidence.

Is Dr. Lockyer's statement that his "*spot-activity* tracks" "are *not* tracks on the solar disc," and that his paper, read before the Royal Society in 1904, February 11, has been "misunderstood," intended as a withdrawal of these descriptions and definitions of "spot-activity tracks" which I have quoted—in fact, of all the main body of his paper? If so, I think it was a pity to publish in "Knowledge and Scientific News" a diagram to explain how he had been led to take up a position which he now finds to be untenable.

Dr. Lockyer objects to the note on p. 159 in this journal for July, and claims that Father Cortie rather corroborated than opposed his result. I do not so read Father Cortie's paper. His words are:—

> "These facts, however, as to the persistence of the disturbance in definite regions at some epochs, and dearth of spots at others, do not lend much countenance to the view of the variation in latitude being affected by a series of 'spot-activity tracks.'" (*Monthly Notices*, Vol. LXIV., p. 766.)

The last two sentences in Dr. Lockyer's letter form a claim which ought not to have been made. He says:

> "I pointed out, as one of the main results of my investigation, that outbursts of spots in high latitudes are not restricted simply to the epochs at or about a sunspot minimum, but occur even up to the time of sunspot maximum." ("Knowledge & Scientific News," 1904, August, p. 182).

Dr. Lockyer's "investigation," so far as it relates to the years 1874-1902, consisted solely in taking the results of my paper, prepared by the desire of the Astronomer Royal for the Royal Astronomical Society, 1903, May 8, and adding the figures there given, in sets of ten, of five, and of three. A computer of average skill would do this easily in a couple of hours. But the effect of this treatment would not be to bring out the fact to which he alludes, but rather to obscure it. He found the fact ready to his hand, explicitly set forth in three-fold fashion in this paper of mine upon which he was avowedly working. It was set forth in the diagrams, in the numerical tables, and in the brief preliminary text. The latter ran thus:—

> "Spots in a higher latitude than 33° were at all times rare, and when seen were never large or long-lived. Taking them as a class by themselves they were seen irregularly, appearing at times which did not seem to bear any fixed relation to any one of the four chief stages of the sunspot cycle—minimum, increase, maximum, and decline. Omitting these spots in very high latitudes—a term which would cover a zone 10° wide in each hemisphere, from 33° to 42°, for no spots were observed in a latitude greater than 42°—the years of maximum, 1883 and 1893, showed spots in practically every latitude between 30° north and 30° south, and they were numerous from about 8° to 24° in both hemispheres." (*Monthly Notices*, Vol. LXIII, p. 452.)

A New Departure in Nature Printing.

By T. E. James.

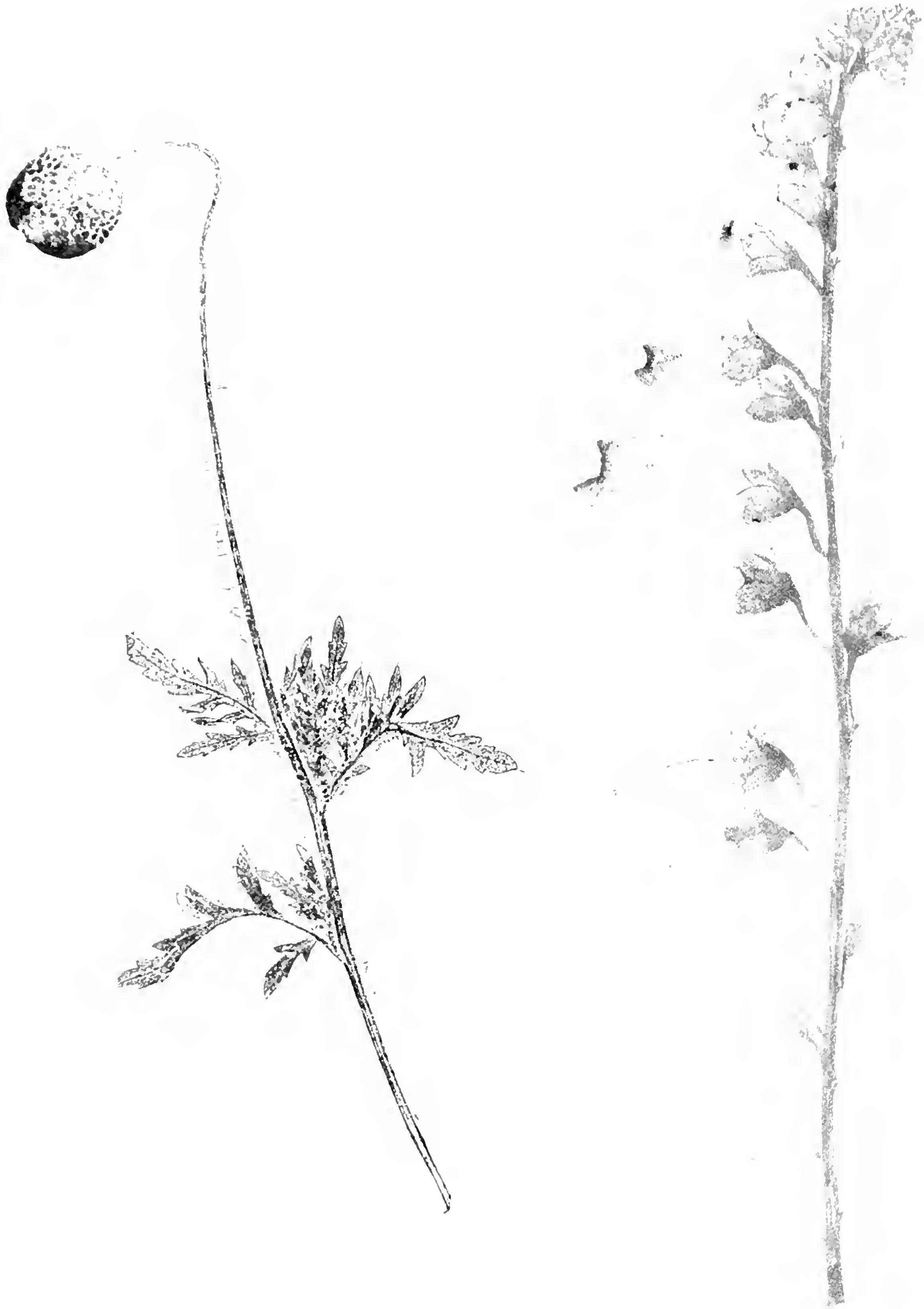
The production of impressions of leaves, ferns, lace, feathers, or other natural and artificial objects by methods adapted to illustrate their outlines and surface features, has long engaged the attention of experimentalists. The records of old attempts in these directions are, indeed, of singular interest. They point to extraordinary industry on the part of workers in the art, though this frequently outstripped manipulative skill, a circumstance, perhaps, not to be wondered at, considering the means at hand, and the operative difficulties.

Fig. 1.—Blackberry Leaf.

We read of an observer who, in 1050, obtained nature-prints of the dried leaves of plants by the aid of sooty depositions. When the leaves were placed between paper and carefully rubbed over, the adherent smokiness was transferred, leaving a pictorial representation of the objects. Prof. Kniphof, of the University of Erfurt, published at Halle, 1757-61, his "Herbarium Vivum," a curious work in twelve folio volumes, which contained no fewer than twelve hundred printed plates of natural impressions. A single plant specimen is depicted on each plate, in many cases portraying its whole aspect, all the examples being hand-coloured. The title-pages carry a border of plants, introduced for ornamental purposes; and on some of these appear butterflies in brilliant natural hues. It seems that printer's ink was used to obtain the initial impression, combined with pressure on the object. Kyhl, of Copenhagen, was also engaged in 1833 in inventive methods. He describes his process thus:—"As a correct copy of the productions of Nature and Art must be of great importance, I submit a method I have discovered, whereby copies of most objects can be taken, *impressed into metal plates*, which enables the naturalist and botanist to get representations of leaves, scales, etc., in a quick and easy way; these copies will give all the natural lineaments with their most raised or sunken veins and fibres; and the artist can, by means of this invention, make use of Nature's real peculiarities; while the merchant can produce patterns of delicately-woven or figured stuffs, laces, ribbons, and so forth." Subsequently, in 1851, Dr. Branson communicated to the Society of Arts his views on the practicability of adopting the electrotype process for the accurate reproduction of original impressions, when the latter were taken in gutta percha. This marked a long stride in advance, and following it, came the adoption of lead as a mould, coupled still with the electrotype system of casting a durable copy. At this stage, Worring, of Vienna, made many notable improvements, which led to important practical results. In 1859, appeared the nature-printed "Ferns of Great Britain and Ireland" (Bradbury), and, in 1859-60, Johnstone and Croall's "Nature-Printed British Seaweeds." Mention should also be made of a paper in the Vienna *Denkschriften*, in 1894, which was illustrated by nature-printed plates of beech leaves, in sepia monochrome.

The ingenious "Physiotype" reproducing system, now being brought to notice, is due to the inventive skill of Mr. Francis Sheridan, who has patented the process. In this, inks or other fixing media are superseded, the novelty of the method consisting in the use of a fine powder, the chemical action of which is responsible for the fac-simile. The modus operandi, as carried out by Mr. Sheridan, is exceedingly simple. An object

Fig. 2.—Leaf of Woundwort.



Figs. 3-4.—"Physiotype" Impressions of the Poppy and Foxglove (natural size).

for reproduction is placed upon white paper, and suitable pressure is applied by the hand or other means. The operation leaves no visible trace of an impression, nevertheless, when a small quantity of the powder is lightly passed over the paper, an impression appears on the surface, delineated as a print in the style of our illustrations. Each is absolutely permanent. The author claims a wide range of application for his process in nature-printing, and printing by contact. Its adaptability for the rapid production of impressions of the thumb and finger, of the palm of the hand, or sole of the foot, may be very readily demonstrated, and strictly "while you wait." Representations of flowers,

Fig. 5.—Oak Leaf.

leaves, grasses, ferns, wood sections, and similar natural objects are also within its province; as well as fac-similes of lace and other patterns, and the designs on coins and medals. One of the advantages of the "Physiotype" print is that it can be used as an artist's lithograph and transferred to stone, zinc, or aluminium. By this means it is possible to print off any number of impressions, and to produce them, if required, in one or several shades of colour.

The precise applicability of "Physiotype" records, and the development of the process as a nature-printing method need not be discussed here. But, if we may say so, it would certainly appear to provide a welcome auxiliary to the teaching of botany in the field. The production of a *self-picture* of the leaves, fruit, or other parts of a freshly-gathered plant is readily obtainable by its means, and the results are of a decidedly attractive and instructive character. As an adjunct to the pursuit of "Nature Study," it should prove of great value in stimulating the latent observational faculty of children. With the interesting prospect before them of producing a pictorial fac-simile of a living leaf, flower, or section, boys and girls might

Fig. 6.—Impression of a Section of Wood.

be the more easily persuaded to collect material from the countryside. For example, a series of leaves might be brought together illustrative of their composite qualities of structure, that is to say, of contour, venation, serration, difference between upper and lower side, and so forth. The teacher would apply the lesson. Our photographs from "Physiotype" impressions of leaves (figs. 1, 2 and 5) demonstrate the point. Again, entire specimens of plants are susceptible of teaching effort, where the mode of inflorescence is noted, form of bud and corolla, attachment of anthers, the presence of stipules, hairs, and other characters of growth.

Fig. 7. Finger Prints showing Whorls (reduced).

Some examples of common plants in flower at the time of writing were gathered and submitted to the "Physiotype" process. Each was essentially a living specimen, and no more was done in preliminary manipulation than to use such slight pressure as would ensure the flatting down of the plant in a natural

position before laying it upon the white paper which was to receive the invisible impression. Our illustrations (figs. 3-4) are of the poppy and foxglove. With practice, no doubt, it would be possible to obtain even better results than are here given. Still they very fairly represent the outcome of a provisional trial to secure the reproduction of living plants.

Fig. 8.—Enlargement of a Rolled Finger-print.

Wood sections are well adapted for fac-simile. Fig. 6 is from a sample kindly lent by Dr. Russell, F.R.S.

The final illustrations (figs. 7-8) demonstrate finger printing.

On all grounds Mr. Sheridan deserves to be congratulated on what we must recognise to be an exceedingly interesting development in nature-printing.

Birkbeck College.

The new session of Birkbeck College, which begins on Monday, October 3rd, will be opened by an address delivered by Dr. Mackenzie on "The Influence of Pure Science on Progress." Among those who will deliver lectures or addresses on the Wednesday evenings during the coming session are the Dean of Ely, Colonel Sir Thomas Holdich, Sir Robert Ball, and the Rev. J. M. Bacon. From the calendar of the session 1904-1905, which comprises the usual day and night classes for the preparation of candidates who enter for the preliminary, intermediate and final examinations for the London University Degrees in Science and Arts, we learn that during the first term last year the class entries were, evening, 3166; day, 582. During the year sixty-four students passed examinations of the University of London (seven with honours), while other distinctions—scholarships, exhibitions, prizes, certificates, and medals—were gained at the examinations of various boards and societies; twelve students were successful in the examinations for Assistant Surveyor of Taxes, ten gained appointments as Assistant Examiners in the Patent Office, and others obtained good appointments in other branches of the Civil Service. Beyond this testimony to the practical service of the "Birkbeck" to the persevering student, other testimony must be borne to the excellent work it is doing in spreading the systematic practical knowledge of science among its widely distributed constituency.

NOTES.

ASTRONOMICAL.

Annals of the Harvard College Observatory.

Two contributions have recently been issued under the auspices of Harvard College. The first of these is the volume for 1901 and 1902 of the Blue Hill Meteorological Observatory, and the expense of its publication only is borne by Harvard College, all the expenses of the observing stations, instruments, and investigations being borne by the Director, Mr. A. Lawrence Rotch. In addition to maintaining the routine observations and automatic records at three stations—one at the Blue Hill Observatory itself, a second at the base of the Great Blue Hill, and a third at the Neponset Valley—several investigations were undertaken, chief amongst which was the exploration of the air with kites. Mr. Rotch is the American member of the International Committee for Scientific Aeronautics, and as far as possible flew his kites on the specified international days, and when flights were not made on these days, it was due to lack of wind at the ground, as a velocity of at least six metres per second is required. If it is desired to certainly fly a kite on any particular day, Mr. Rotch advises the instalment of the apparatus on a steamer, which by creating a wind through its motion will enable a sufficient current of air to raise the kite. He advises by this means an investigation of the meteorological conditions above the trade-wind and doldrums. Other investigations have also been conducted on the audibility under various weather conditions, at Blue Hill; of the effect of weather conditions on the optical refraction of the lower atmospheric strata; and of the electrification of the air and the quantity of carbon dioxide contained in it. These last measurements seem to indicate that there are two maxima of potential during the day, which are not always well defined, and sometimes merge into one, occurring about noon or a little before, and in the majority of cases there is a steady fall of potential from about 2 p.m. until late in the evening, when the electrification seems to reach a constant and low value.

The second contribution from Harvard College is the determination by Mr. Winslow Upton, during the year 1896-97, of the position of the Arequipa station in Peru. Briefly it results:—

Latitude, − 16° 22′ 28·0″.
Longitude, 4h. 46m. 11·73s. west of Greenwich.
Height above sea-level, 2451·4 metres = 8043 feet.

Harvard College itself issues its circular (No. 74) on variable stars of long period, and urges that in such cases it is useless for observers to employ Argelander's exact method of sequences. As it is, when the measures made at different observatories on the same night are compared, they often differ by half a magnitude or more, owing chiefly to the red colour of most of the long-period stars. The resulting magnitudes would be nearly as good if the observer would merely state that the variable was surely brighter than one star and fainter than that next it in the sequence, without attempting to estimate grades. Considering the large number of variables of which we have no current observations, our knowledge of their variations could thus be greatly and easily increased.

* * *

Bulletins of the Lowell Observatory.

A number of interesting bulletins (Nos. 9-13) have arrived from the Lowell Observatory, and indicate the varied and valuable researches that are carried on there. In No. 9 Mr. Lowell gives a new determination of the position of the axis of rotation of Mars, championing the direct and observational

method as used by Schiaparelli, rather than the direct method used by Struve, of the calculation from the nodal or absidal precession of its satellites' planes. Incidentally Mr. Lowell points out that there is a strong discordance between the results of Schiaparelli and Struve. Mr. Lowell's own results are as follows:—

Position upon the Earth's Equator	315° 32'. R.A..	54° 51' Dec.
Intersection of Martian Equator and Martian Ecliptic	85° 56'.	24° 32'.
Inclination of Martian Equator to Ecliptic . .		22° 55'.

In No. 11 Mr. V. M. Slipher gives a list of five stars which he suspects to be spectroscopic binaries. These are Alpha Andromedæ, Alpha Libræ, Sigma Scorpii. X Sagittarii, and Epsilon Capricorni.

In No. 12. on "The Cartouches of the Canals of Mars," Mr. Lowell restates his conclusions: (1) The canals develop down the latitudes after the melting of the polar cap, the development proceeding across the equator into the planet's other hemisphere; and they do this alternately from either pole. (2) The canals are from their behaviour inferably vegetal. (3) They are of artificial construction.

In No. 13 Mr. Slipher gives plates and details of the spectra of Neptune and Uranus. He notes that he finds indications that free hydrogen is very plentiful in the atmosphere of Neptune, and is abundant on Uranus, but not so much so as on Neptune. He also considers that some unknown light gases related to hydrogen and helium might also be present and account for certain unknown bands. Helium he could not observe with certainty owing to the insensitiveness of his isochromatic plates in the D region of the spectrum.

In one matter astronomers certainly owe a debt to Mr. Lowell—namely, for his introduction of new words—words that are at least new to the very limited astronomical vocabulary. The expression "cartouches" is a case in point; and another is offered by bulletin No. 9, where he says that "for direct handling of the subject the planet's polar caps offer the most trustworthy 'helves.'" We scarcely think the use of the terms "expurgated" and "unexpurgated" in the same bulletin so happy. They suggest Mr. Bowdler, and that Mr. Lowell's bulletins are unsuitable reading for the young person.

* * *

The Royal Astronomical Society of Canada.

The Astronomical and Physical Society of Toronto has been accorded the above new title, and has just issued its selected papers and proceedings for 1902 and 1903, which prove very interesting reading. The President's address for 1903 reviewed the recent researches in cosmical physics. Mr. W. H. S. Monck gives a valuable catalogue of aërolites, and Mr. Arthur Harvey follows it by a paper on "Shooting Stars and Uranoliths," with special reference to the Mazapil (Mexico) meteorite. He supplements Mr. Monck's catalogue, and concludes that "aerolites are evenly distributed throughout space and move at various angles with the plane of the ecliptic," so that there is no evidence to show that there are drifting clouds of matter in space which might be the exciting cause of solar and our own magnetic disturbances. A second paper by Mr. Harvey is practically a continuation of the same subjects, and is called the "Vagaries of the Mariner's Compass." In this is passed in review the researches which have been variously carried on both in terrestrial magnetism, on auroral displays, and on the solar work at the Greenwich and Yerkes observatories. The final paper is on "Women's Work in Astronomy," by Miss Elsie Dent. This is a most disappointing one; it is undiscriminating and full of errors. What is most striking is the number of omissions of the names of American women astronomers. The writer places both Mademoiselle Klumpke and Madame Flammarion at the Paris Observatory, and she places Lady Huggins in the same rank as the last named, both as deriving their astronomical rank solely from their husbands' position—a gross injustice to Lady Huggins. Miss Dent is unaware that Miss Klumpke left the Paris Observatory some three years ago to marry Dr. Isaac Roberts. She describes Miss Elizabeth Brown as having been sent to Russia in 1887 to observe the Total Solar Eclipse of that year by the British Astronomical Association, which was not in existence until three years later.

Meteoric Observation.

Mr. W. F. Denning writes from Bristol:—

"Perhaps more mistakes have been made in this department than in any other field of astronomy. Certainly some of the observations have been very wild, and more obviously calculated to excite ridicule than to win confidence. In this, as in other branches of observation, it would have been better had certain observers never essayed to do anything, since their results are affected by personal equation or individual idiosyncrasies of such marked character that their work rather damages than benefits the cause. There is no doubt that the majority of the radiants hitherto determined are useless, being either pseudo positions or so inaccurate that their elimination is desirable. Their retention and combination with correct radiants have the effect of detracting from the value of the latter.

"To attempt to detail the errors made in this branch would serve no useful purpose, and it would occupy a large amount of space. One observer, a few years ago, watched the Perseids, and saw the meteors shooting not from the radiant, but towards it. Numbers of meteors were recorded in Camelopardus and surrounding constellations, but all of them were dashing towards the radiant!

"Another observer noted that many Perseids, after traversing their paths, made return journeys along the same paths. He also saw many large cloud-like meteors, and the sky produced flashings, coruscations, &c., which he attributed to meteoric action.

"Other observers frequently record meteors whose paths are suddenly bent or crooked. Others, again, frequently note curved paths, and some observers see meteors which suddenly stop and shoot back nearly in an opposite direction.

"Practice, experience, and care will not always form a good observer. The most essential quality is self-aptitude or natural capacity which varies greatly in different individuals. Meteoric observers, like poets, are born, not made. Education can never ensure very high proficiency unless the learner possesses inherent qualities which materially help him to acquire it.

"As far as my experience goes, there have been observers whose radiants cannot be relied on to within 10°; there have been others whose positions can be depended upon to within 2° or 3°. Unfortunately it is often impossible to certainly single out the good from the indifferent positions, and so our accumulated results form a curious medley of precise and pseudo results. Though this is undoubtedly the case, however, we know the correct radiants of a considerable number of showers.

"Fortunately we have many reliable observers working to-day at this department, and I need only mention the names of Astbury, Backhouse, Besley, Bridger, Brook, Alex. Herschel, and King.

"Other good men, such as Blakeley, Booth, Clark, Corder, R. P. Greg, Wood, and a few more, have relinquished labours in this field.

"Prof. Alexander S. Herschel has accomplished a vast amount of valuable meteoric work during the last 45 years, and this department of astronomy will ever stand indebted to him as one of its most able and tireless pioneers."

* * *

A New Chart of Mars.

Herr Leo Brenner has recently issued a new chart of Mars from observations made in Lussinpiccolo from 1894-1903. The chief feature of the chart is the indication of the minor markings, "canals" and "lakes," in different colours according as they have been discovered by Schiaparelli, Lowell, or by Brenner himself. The result is a network of lines so close and intricate as to prove to demonstration that it cannot possibly represent any real and permanent features of the surface of the planet. The majority of these markings, exceeding three hundred in number, if actually observed must belong to one of two classes; they must either be pure illusions on the part of the observer or must be perfectly ephemeral markings on the planet, possibly of the nature of meteorological change. The leading markings, the great "lands" and "seas," are shown under forms so stiff and rectangular, and with so little of detail, as to indicate that Herr Brenner enjoyed very few advantages as to atmosphere or telescopic definition, or else that he was singularly unfortunate in profiting by them.

A Scheme for the Comparison of Climates.

Is it possible to express the pleasantness or unpleasantness of a climate on a scientific scale? Captain W. F. Tyler, F.R.Met.Soc., has attempted to form such a scale. Concluding that the two dominant factors influencing our sensation of comfort are temperature and humidity, he has coined the word "hyther" apparently from the first syllables of "hygrometer" and "thermometer" to indicate this joint effect. A perfectly pleasant day is registered 0 on this hyther scale, and an intolerably oppressive one as 10. Captain Tyler's own observations of "hyther" extend over several years, but in the end of the summer of 1902, he was able to get the co-operation of eleven other observers for the systematic observation of "hyther" throughout the month of August. The results of the comparison showed that most persons would require a considerable amount of practice before their observations could be considered trustworthy, but some approach was made towards the establishment of a definite law connecting the temperature and humidity with the hyther sensation. At the same time there were indications that some other factors, possibly barometric pressure or electric conditions, had an appreciable influence upon the sensation. The subject seems well worth working out on a more extended scale.

* * *

The Paris Observatory.

The annual report of the Paris Observatory for 1903, presented to the Council on March 22 of the present year, deals with a number of researches of special interest. The seventh section of the Atlas of the Moon has appeared, containing seven plates which seem the most successful yet issued, and in some respects to show a considerable advance over the best views of the moon obtained by the eye at the telescope. With respect to the Astrographic Chart, eleven plates have been passed as satisfactory, and thirty-five charts containing the triple images of 47,300 stars have been distributed. It is hoped that the second volume of the Photographic Catalogue will appear by the end of the current year. The determination of the solar parallax from the photographic observations of Eros is advancing towards completion. Of standard stars 1661 meridian observations have been made, and 10,858 photographic observations of comparison stars, of standard stars, and of stars near the path of Eros. Three important researches based upon new methods are included in the programme for the future work of the observatory: the first relates to the determination of latitude and of its variations; the second is for the precise determination of the constant of aberration, two portions of the sky, distant 90°, being presented in the field of the instrument at the same moment by means of a double mirror; and the third relates to the employment of M. Lippmann's photographic object-glass in meridian observations.

* * *

Re-discovery of Encke's Comet.

Encke's comet was re-discovered at the Königstuhl Observatory on September 11 at 13h. 10·9m. local mean time. Its right ascension at discovery was 1h 46′ 16″, and its declination N. 25° 24′. This is the thirty-sixth return of the comet since its discovery in 1786; the twenty-ninth during which it has been observed.

BOTANICAL.

By S. A. Skan.

The *Comptes Rendus*, vol. cxxxvii., contains some valuable observations on the germination of seeds of orchids by Mons. N. Bernard, whose experiences warrant his making the interesting and rather remarkable statement that germination, at least in the case of some seeds of *Cattleya* and *Laelia* with which he experimented, is wholly dependent on the presence in the embryo of a filamentous endophytic fungus. In a fortnight after sowing the seeds some minute spherules, rendered evident by their green colour, were produced. Some of the epidermal cells of these bodies elongated into short papillæ, but did not form any true hairs. It was observed that in aseptic sowings, even after the lapse of five months from the time when the green spherules made their appearance, no further development of the seeds had taken place. Many were destroyed by mould, sooner or later. If, however, the seeds in the state indicated were transferred to a tube in which was a culture of a certain hyphomycetous fungus, further growth almost immediately resulted, and it was found that the hyphæ of the fungus had penetrated the median part of the suspensor and the adjacent cells of the embryo. In fifteen days the seedlings had assumed their characteristic top-shaped appearance, developing a terminal bud and long absorbing hairs. In the cultures, besides the fungus which Mons. Bernard regards as necessary to germination, a coccobacillus was present, but it did not appear to have any effect, either in hindering or promoting germination; if, however, other fungi or bacteria were substituted for the particular kind of fungus found to be essential, the seeds, instead of germinating, were destroyed.

A rose which has created a great deal of interest in horticultural circles is the subject of one of the plates in the September number of the *Botanical Magazine*. The late Sir Henry Collett met with this rose, to which he gave the name of *Rosa gigantea*, as a very striking object in the forests of the Shan Hills in Northern Burma, and it was through him that seeds were received at the Royal Botanic Gardens, Kew, in 1888. No difficulty was experienced in getting the seeds to germinate, and the seedlings soon developed into plants remarkable for the enormous length of their shoots, one of these in the Temperate House reaching a length of fifty feet. Visitors to the Succulent House may have observed the robust specimen planted in the central bed there, which had grown along the roof, and then out through a ventilator into the open air. But though growths were produced in almost embarrassing freedom, no flowers have ever been borne by the Kew plants. Indeed, it is believed that only in two gardens in this country has the plant flowered at all. From one of these—Albury Park, Guildford—the material was obtained from which the *Botanical Magazine* drawing was prepared. The flowers are white, or white tinged with yellow, and are from four to six inches in diameter. The same rose was found first in Manipur, and it is now known to occur in Western China.

ORNITHOLOGICAL.

By W. P. Pycraft.

Brush Turkeys breeding in Confinement.

Mr. Bertling, in the August number of the *Avicultural Magazine*, concludes his notes on the breeding of the Brush Turkeys (*Talegalla lathami*) in the Gardens of the Zoological Society.

His account, though short, is extremely interesting and of considerable scientific value.

Some time since, these birds constructed a mound of the usual type, and deposited therein a number of eggs. The nestlings being overdue, it was at last decided to at least partially explore the mound, and this resulted in exposing three eggs. These lay about one foot apart from each other, and some 18 inches from the surface. They were placed with the large end upwards, and had certainly not been turned, as a deep hole, of the shape of the egg, was left on its removal. Moreover, the egg did not touch the bottom of the hole, inasmuch as the small end was quite white, whilst the rest of the shell was stained by contact with the mould.

A further search revealed a chick, evidently dazzled by the sudden glare of the light. The "quills" of this bird were nearly 3 in. long, and as it could fly fairly well, he says, "I have come to the conclusion that the young remain at least 36 hours, or longer, in the mound before making their appearance, as three others, hatched in an incubator, were not nearly so advanced when hatched."

The shell is very thin, so that the young do not chip round the upper part of the egg in order to make their escape, but

appear to shatter the walls of their prison by giving a violent wriggle. They do not immediately obtain freedom, however, but still remain encased in the inner membrane of the shell, which is ruptured some hours afterwards.

When first hatched the primaries and secondaries are ensheathed in a "thin filmy covering" which gives the wings the appearance of being still undeveloped, but directly the chick dries this membrane peels off, leaving the bird ready for flight.

At three weeks the black feathers of the adult plumage are distinctly visible through the "down," and at six weeks the birds are almost indistinguishable from the parents.

* * *

Breeding of the Tataupa Tinamou.

(*Crypturus tataupa.*)

Mr. Seth-Smith is the first to have succeeded in breeding this rare bird in confinement, and as nothing was hitherto known of its habits at this time his short description thereof in the *Avicultural Magazine* for August is of considerable interest.

The eggs are incubated by the male only. From the moment he began to sit the female resigned all interest in the matter; indeed, if she approached, her mate rushed at her open mouthed so that she fled in terror! Before leaving them the eggs were most carefully covered up. After the escape of the young from the egg shell the male broods them for some hours before bringing them out into the open.

The female does the courting, calling to her mate and then running to him, and displaying in the most curious attitudes.

When alarmed these birds adopt the peculiar device of throwing themselves forward on the breast and throwing the tail in the air so that the under-tail-coverts form a screen to hide the body; which in consequence becomes hard to distinguish from the surrounding herbage and undergrowth. Even very young chicks, when they suspect danger, squat and turn up their sprouting tails, but whether instinctively or in imitation of the parents the author does not say.

* * *

The Weight of Eggs.

In our last issue, it will be remembered, we referred to a paper on the loss of weight of eggs during incubation. The *Zoologist* for August contains some extremely interesting notes on the range of variability in the weight of eggs of wild birds, which is much greater than one would have imagined. The eggs of the Charadriidæ were used to furnish the material for this investigation, and the strictest care was used to select only unincubated eggs, thus eliminating the error due to loss from this cause. The weight of the whole clutch, and not of single eggs, is given. Altogether, about a dozen species have been studied in this connection, and four or five clutches of each species have been weighed. In *Ægialits hiaticula*, the lightest clutch weighed 45·148 grammes, the heaviest 50·450 grammes; in *Charadrius pluvialis* the differences were 130·167 grammes and 151·290 grammes; in *Vanellus vulgaris*, 106·621 and 117·434 grammes; in *Numenius arquatus*, 320·114 and 348·116 grammes; in *Totanus calidris*, 82·164 and 92·687 grammes. It would be interesting to compare the relative differences in weight between the birds of the species enumerated and their egg clutches, and to note the difference between the activity of their young on hatching. So far, no one seems to have noticed whether this differs to any appreciable extent among the different species of Charadriidæ.

* * *

The Systematic Study of Bird Life.

The foundation of an Ornithological Observatory is an event which may be said to mark an epoch in the study of ornithology. Such an establishment has just been started in the United States. It is to be known as the "Worthington Society for the Investigation of Bird Life," and has been erected and endowed by its founder, Mr. C. C. Worthington, on his estate at Shanee, Monroe County, Pennsylvania.

The programme laid down is exhaustive in its comprehensiveness, but we may draw special attention to one or two of its particularly interesting items. In the first place particular attention is to be paid to life histories. Observations on an elaborate scale are to be made so as to embody as many details as possible concerning the growth, food, and habits of individuals in a wild state. The study of the vexed question of variations, their nature, and cause; and colour changes with respect to age, sex, moult, season, and climate should yield much. The problems of heredity, experiments in hybridising, and psychological observations are to be carried on in specially constructed aviaries. Another important feature is the proposal to test the possibility of breeding insectivorous and other useful birds with a view to re-stocking depleted areas, as has been done in the case of fish by the Fish Commission.

The carrying out of this great enterprise has been entrusted to Mr. W. E. D. Scott, the Curator of the Ornithological Department of the Princeton University. This augurs well for its success; indeed we know of no other man who is so peculiarly fitted for such a task. He will be aided by a staff of assistants.

We cannot refrain from expressing a desire to see a similar institution at work in this country. Perhaps the Board of Agriculture may be induced to consider the matter.

* * *

Snap-shots from Bird Life.

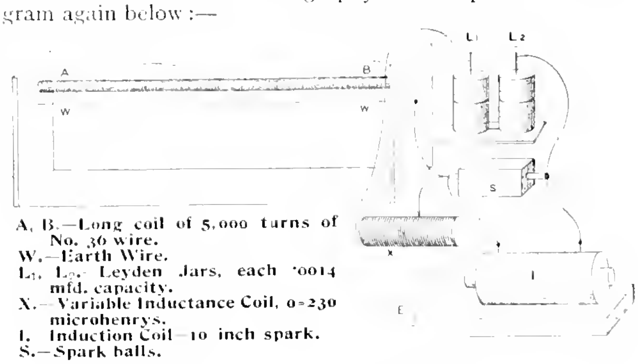
We have peculiar pleasure in bringing to the notice of our readers a very wonderful collection of stereoscopic pictures which have just been issued under the above title. Every picture has been taken from life—and about their genuineness there can be no question—by M. P. L. Steenhuizen, of Amsterdam. Though these photographs were taken in Holland, all the birds in the series occur in Great Britain. A more marvellous and a more beautiful collection it would be impossible to imagine, and at the present time they are probably unique. Since there are no less than 48 slides in all, we cannot give a list of the subjects, and we find it peculiarly difficult to select any for special mention, for all are alike exquisite. But to give an idea of the variety of the selection, we may mention as especially striking the nest and eggs of the pheasant, the nest and young of the marsh harrier, the nest and young of the spoonbill, the nightjar and its eggs, and the nest and eggs of the great reed warbler.

I shall be glad to give particulars to those who may desire to procure copies of this really wonderful series.

PHYSICAL.

Electrical Wave Measurement.

In the June number of "Knowledge," a description was given of the means which Professor J. A. Fleming, F.R.S., employs to investigate the propagation of electric waves along spiral wires; and a diagram was appended to show the way in which the apparatus can be employed for measuring the length of waves used in wireless telegraphy. We reproduce the diagram again below:—



A, B.—Long coil of 5,000 turns of No. 36 wire.
W.—Earth Wire.
L_1, L_2.—Leyden Jars, each ·0014 mfd. capacity.
X.—Variable Inductance Coil, 0–230 microhenrys.
I. Induction Coil—10 inch spark.
S.—Spark balls.

In practice the method consists of establishing stationary electric waves on the spiral wire, and of deducing, by mathematical reasoning, the wave length of the induced wave. The experiments described previously in "Knowledge" were made with a long helix of insulated copper wire, wound in one layer on a wooden rod. Wood, however, has since been found to be unsuitable for obvious causes; and an ebonite rod

has been substituted. The helix of wire consisted of 5000 turns, the length being 200 centimetres. If such a helix is placed in connection with an oscillating circuit consisting of a condenser or Leyden jar, a spark gap, and a variable inductance, stationary waves can be set up on the helix by adjusting the inductance in the oscillating circuit. In order to detect the nodes and antinodes of these stationary oscillations, Professor Fleming makes use of a vacuum tube, similar to that used in spectrum analyses, and preferably one filled with the rare gas, Neon. Rarefied Neon seems to be extremely sensitive to the presence of variable electric force through it; hence, if such a tube is held perpendicular to the helix, and moved parallel to itself along it, it glows brightly at the antinodes, but not at the nodes. In this manner the internodal distances can be measured with considerable accuracy, and the wave-length of the stationary oscillation measured.

Now the velocity with which the wave is propagated along the spiral can be shown to be inversely proportional to the square root of the product of the capacity and inductance of the helix per unit of length. Professor Fleming has perfected of late years methods for measuring very small capacities and inductances, and in the case of the above-named helix the inductance is equal to 100,000 centimetres per centimetre, whilst a capacity of the helix is [illegible] of a micro microfarad. (1 micro-microfarad = 10^{-6} microfarad.)

From these data the velocity of propagation of electric waves along the helix can be shown to be 235,000,000 centimetres per second. This figure is confirmed in the following manner: The capacity and the inductance in the oscillating circuit are both measured when the first harmonic oscillation is formed on the helix, and under those conditions the half wave-length was found to be 140 centimetres, whilst the frequency in the oscillating circuit, as calculated from the capacity and inductance, was found to be $0{\cdot}847 \times 10^{6}$.

Having, therefore, the wave-length and frequency, we find their product gives a velocity of 235,000,000 centimetres per second, which agrees with the figure determined from the constants of the helix.

The best form of inductance to be employed in connection with the oscillating circuit is a square of one turn of wire: the employment of spiral coils leads to errors due to passage of a dielectric current from coil to coil. The improved instrument which Professor Fleming has now constructed, and which is based on the foregoing considerations, he calls a "Kummeter." It is constructed as follows: A long ebonite rod is wound over closely with silk-covered wire in one layer, and this is supported on insulating stands. On this long helix slides a metal saddle having some layers of tinfoil interposed to make good contact between the saddle and the helix. This saddle is connected by a flexible wire with the earth. One end of the helix is furnished with an insulated metal plate, which is placed in apposition to another metal plate connected to the oscillating circuit of the transmitter. The process of measuring the wave consists in sliding the saddle along until a Neon vacuum tube indicates the presence of one node halfway between the saddle and the plate. When this is the case the distance from saddle to plate is one wave-length of the stationary wave on the helix.

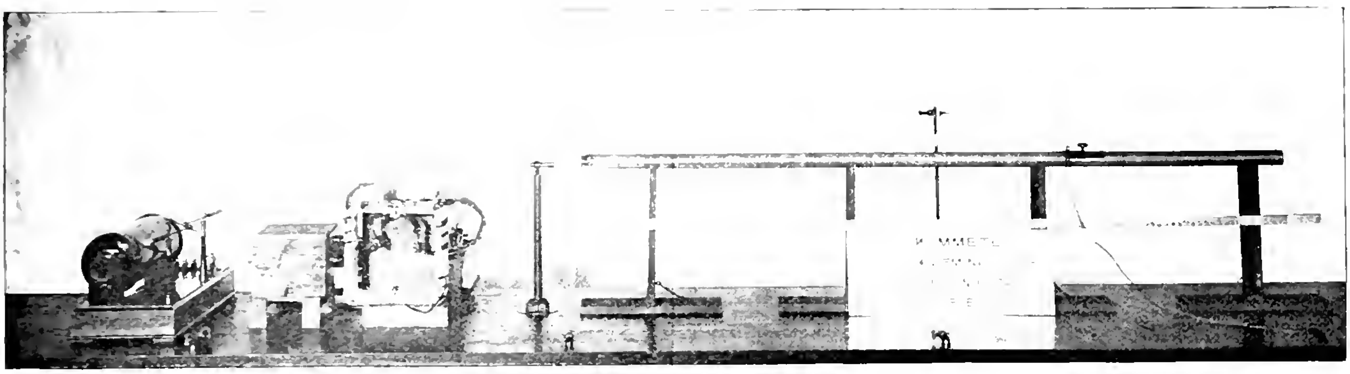
From the constants of the helix the velocity of the wave along it can be calculated as above shown, and hence the frequency of the oscillating circuit becomes known. If this frequency is divided into the velocity of light, reckoned in feet, it gives the wave-length in feet of the wave radiated from the associated aërial, provided that the aerial radiating wire has been tuned to be in resonance with this oscillating circuit.

This instrument also provides the means of measuring small inductances, and also the frequencies in oscillating circuits, which are much higher than those which can be determined by photographing the spark.

* * *

Thought Rays.

M. di Brazzà, a student at Liège, who sent an account of Becquerel's work on radio-activity to the *Secolo XX*, for January, 1903, now describes the I-rays as discovered by himself when repeating the N-ray experiments of M. Blondlot and of Professor Charpentier. Charpentier succeeded in demonstrating that the human body emits N-rays. He found that the phosphorescence of certain substances is increased when they are brought close to a nerve or contracting muscle, *i.e.* muscular work is accompanied by a marked emission of N-rays. By means of a simple apparatus, a lead tube 7 cm. long (lead was chosen because it was opaque to the human rays, and accordingly lessens diffusion), closed at the end by a sheet of paper, or bit of silk covered with phosphorescent calcium sulphate, it is possible to observe the different nervous centres of the cerebral cortex. Thus by placing it in apposition with Broca's centre (the centre of articulate speech) while the patient is talking, variations are produced in the luminosity of the phosphorescent calcium sulphate. In another experiment, Charpentier saw the phosphorescent substance shine all down the line of its application to the spinal cord. Charpentier concluded that the emission of rays goes *pari passu* with activity of function, whence we should be in possession of a new method of studying nervous and muscular activity. Di Brazzà claims to have demonstrated what Charpentier only surmised, *i.e.* that "the brain is the seat of active radiation." The I (Italy) rays differ from the N in that they can pass through moist substances, and are not bent nor refracted. Di Brazzà observes them directly and indirectly. In direct observation he applies a phosphorescing screen treated with platinocyanide of Ba., or other phosphorescent substances, to the patient's head. The screen is faintly illuminated by a radiographic tube (tubo-focus) enclosed in a wooden box. When the subject concentrates his will, curious oscillations appear in the luminosity of the screen in relation with the patient's psychical activity. When his attention is not concentrated, the light does not flicker. The rays are not emitted equally from all parts of the head. They are *nil* at the forehead and upper part of Broca's centre, increase at the temples and eyes, and reach their maximum behind the ears. In photography, precautions must be taken to secure uniform length of exposure (di Brazzà introduces an automatic interrupter), sensitivity of plate, conditions of development, &c. Di Brazzà always uses ortho chromatic plates.



Professor Fleming's Kummeter.

Wireless Telephony.

In order more closely to investigate the phenomena attending the disruptive discharge of a Ruhmkorff coil, Mr. F. Lifchitz, as recorded in a paper recently presented to the Russian Physico-Chemical Society, places a concave mirror on the axis of the Ducretet commutator working the coil. On account of the synchronism, a fixed image of the spark is obtained on the screen instead of a Federsen band, as obtained in the case of the rotation of the mirror being much more rapid. The image observed is a single one in the case of the spark length being maximum, 2, 3, etc. images—up to some dozens—being realised as the distance of the electrodes from the spark becomes less. In order to be able to record these observations, the author fitted a photographic plate instead of the mirror vertically to the axle of the commutator, when the images of the sparks followed up each other at increasing intervals, beginning with $\frac{1}{16000}$ second. This goes to confirm Hertz's opinion, according to which the discharge of the coil would carry an amount of electricity much greater than that of an electrostatic machine in virtue of the more rapid increase in potential. The number of impulses obtained for the same length of spark varies directly as the intensity of the current traversing the primary circuit. Now let the commutator of the coil be replaced by a microphone acted upon by the voice of the experimenter. Each letter pronounced will result in a series of disruptive discharges, the series of impulses being the longer as the pulsations are stronger. The vibration thus set up may be received by the aid of a decoherer. A whole series of vibrations following up each other at intervals of some 10,000th of a second will result in a single variation in the resistance of the decoherer, being the greater as the series is longer, and the time necessary for producing decoherence being of some thousandths of a second.

ZOOLOGICAL.

By R. Lydekker.

The Blood of Men and Apes.

At the Anthropological Congress recently held at Greifswald, Professor Uhlenhuth described at considerable length the results of experiments he had undertaken with the view of ascertaining whether any closer affinity exists between the blood of the man-like apes and that of man than between the latter and the blood of the lower monkeys and mammals in general. The result is to show that, although it is perfectly easy to distinguish between human blood and that of the lower mammals, it is much more difficult to demonstrate under the microscope a satisfactory distinction between the former and that of apes and monkeys. But this is by no means all; for, whereas the resemblance is greatest between the blood of man and that of man-like apes, it becomes less strongly marked when that of the lower Old World monkeys is compared, still less so in the case of the American monkeys, and least of all when the blood of the lemurs is under comparison. This is exactly what might have been expected to occur, seeing that the lemurs depart most widely of all the Primates from the human type.

* * *

The Gorillas at the "Zoo."

The recent arrival at the Zoological Society's menagerie of two apparently healthy young gorillas was an event of great importance and interest. Unfortunately, the elder of the two (*ætat* 5) did not long survive, succumbing to a disease which was apparently already in its system at the time of its purchase. The other and younger animal, which was supposed to be three years old, has also died. Only two gorillas have previously been exhibited in the Regent's Park. The first of these was a young male, purchased in October, 1887, from Mr. Cross, the well-known Liverpool dealer in animals. At the time of arrival it was supposed to be about three years old, and stood $2\frac{1}{2}$ feet in height. The second, which was a male, and supposed to be rather older, was acquired in March, 1896, having been brought to Liverpool from French Congoland by one of the African Steamship Company's vessels. It is described as having been thoroughly healthy at the date of its arrival, and of an amiable and tractable disposition. Neither of these animals survived long.

So long ago as the year 1855, when the species was known to zoologists only by its skeleton, a living gorilla actually existed in this country. This animal, a young female, came from French Congoland, and was kept for some months in Wombwell's travelling menagerie, where it was treated as a pet. On its death, the body was sent to the late Mr. Charles Waterton, of Walton Hall, by whom the skin was mounted in a grotesque manner, and the skeleton given to the Leeds Museum. Apparently, however, it was not till several years later that the skin was recognised by the late Mr. A. D. Bartlett as that of a gorilla; the animal having probably been regarded by its owner as a chimpanzee.

Of the two recent arrivals at the "Zoo.," one appears to belong to the true gorilla (*Anthropopithecus gorilla*), while the other represents the red-headed gorilla, which has been described as *Gorilla castaneiceps*. It is now definitely known that there are several local forms of gorilla, of which one inhabits East Central Africa; but naturalists are by no means in accord as to whether they should be regarded as species or sub-species. If the latter view be adopted, the gorilla should be included in the same genus as the chimpanzee (*Anthropopithecus*), but, if the former course be followed, it would probably be better to regard the various species as representing a genus (*Gorilla*) by themselves.

Whether it will ever be possible to keep a specimen in captivity in this country till full-grown remains to be seen. Since the above-mentioned 3-year old example was only $2\frac{1}{2}$ ft. in stature, gorillas must probably take something like 15 or 16 years to reach maturity.

* * *

Fossil Mammals in the Ganges Valley.

An extremely interesting discovery of the remains of extinct mammals has recently been made during excavations undertaken for the foundations of the Ganges bridge at Allahabad, India. The remains include those of one or two species of hippopotamus, of a wild ox, and of an elephant, all belonging to extinct species. Apparently all these species are identical with those long known from the valley of the Narbada, considerably further south in India; but it is possible that the Ganges bones, like others discovered in the early part of last century in the valley of the Jumna, may belong to a somewhat later portion of the Pleistocene epoch. In all probability the creatures they represent were cotemporaries of the early human inhabitants of India; and the special interest of the discovery lies in the possibility that it may give rise to investigations for the purpose of ascertaining whether human remains may not occur in the same deposit. In connection with the former existence of hippopotamuses in India, it may be remarked that we have yet to learn why these animals died out while elephants survived.

* * *

Mammoth Skull in Kent.

We have also to record a very interesting palæontological discovery at Erith, in Kent. A short time ago it appears that while some labourers were working in a sand pit at that place, they came suddenly upon an entire skull of a mammoth, at a depth of about 23 feet from the surface, with tusks close on six feet in length. Unfortunately they forthwith proceeded to exhume the prize, which of course at once fell to pieces. Had it been properly treated with size and plaster, it might have been extricated whole, when it would have formed a most valuable specimen, as only one entire British mammoth skull is known.

* * *

The Later History of the Horse.

This subject was discussed at the late meeting of the British Association by Professor Ridgeway, who urged that while the ordinary "cold-blooded" horses of Europe and Western Asia trace their descent to a dun-coloured stock more or less nearly resembling the Mongolian wild ponies, Arabs and thoroughbreds are descended from a breed whose colour was bay, frequently with a white star on the forehead and a white ring on the fetlock. This ancestral bay stock, it is urged, originally came from North Africa, whence it migrated into Western

Asia. There is much in this theory to attract the best attention of the zoologist, although the absence of any evidence that wild horses ever existed in North Africa militates against an African origin for the bay stock. Moreover, when the author suggests that the white "stocking" on the fetlock of the Arab recalls the white rings on the foot of the zebras he is treading on dangerous ground, although he appears to have abandoned his wild theory that the Arab and the thoroughbred are descended from Grevy's zebra.

CORRESPONDENCE.

The Later History of the Horse.

TO THE EDITORS OF "KNOWLEDGE."

SIRS,—Mr. Lydekker, in his interesting paper in "KNOWLEDGE," August, 1904, p. 171, makes a very usual error in dealing with the relative degrees of finish exhibited in Palæolithic and Neolithic implements. Without previous knowledge of the subject of prehistoric implements, a reader would gather that all Palæolithic implements are rude, and that all Neoliths are ground or polished. This impression would to a certain degree receive confirmation by a visit to Bloomsbury. Nothing in truth could be more misleading. If Palæolithic implements are regarded as a class, they show, especially with regard to later types, a remarkable proficiency in the working of flint. The only type which as a class can be termed rude are the oft-abused Eoliths; the Palæoliths certainly do not merit such a term. Again, it was the exception during Neolithic times to grind or polish implements. It is not a little significant to point out that, viewed as a class, Neolithic implements are actually ruder than Palæoliths—the proportion of polished or ground implements to those showing only rough workmanship is infinitesimal. I am aware that the museums do not illustrate this condition of things, but it is an old grievance of the man in the field that on this point the museums are misleading.

Might I suggest that the blocks of Figs. 2 and 3 in Mr. Lydekker's paper appear to be wrongly placed?

Yours faithfully,
J. RUSSELL LARKBY.

Bromley, Kent.

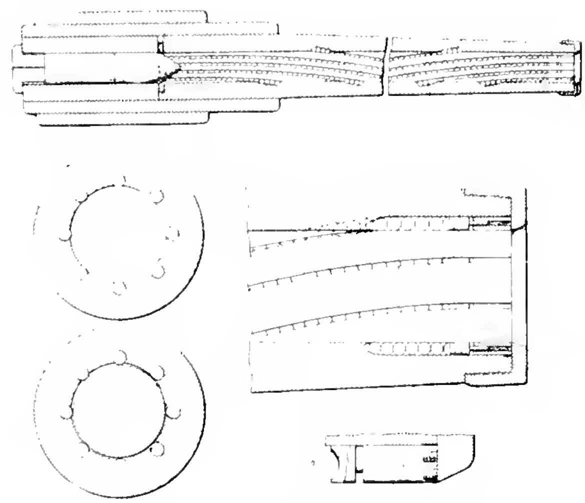
A Ball-Bearing Rifled Gun.

IN spite of the improvements of modern firearms, the device by which rotation is imparted to the projectile as it leaves the gun-bore has remained stereotyped. Yet a brief consideration of the method of "rifling" which imparts the rotatory motion will show that it must interfere with one of the fundamental aims of the gun designer, which is to get his projectile out of the gun with the greatest velocity possible. The projectile, in order that it may be susceptible of receiving rotatory motion, is provided with a band of metal into which the edges of the rifled groove have to force their way. Consequently a large portion of the energy developed by the charge is dissipated in heat in the gun barrel. An American inventor, Mr. Orlan C. Cullen, has devised a method, quite simple, and to all appearance practicable, of avoiding this waste of energy.

He uses a cylindrical projectile of perfectly smooth, hard steel, travelling upon the smooth and almost frictionless path afforded by hard steel ball bearings. In the barrel a number of grooves, usually eight, are cut of completely circular section, except that a small arc is cut off so that each communicates with the bore by a narrow slot. Into these grooves are fitted steel balls, which project through the slots to the extent of about one-twentieth of their diameter, with the result that the projectile travels upon a rolling bed which offers the least possible resistance to both its forward and its rotatory motions. At first sight it might be supposed that the arrangement would not be gas-tight. That, however, is not the case; the projectile is made to fit closely to the balls, and its elasticity, combined with that of the walls of the grooves and of the balls, insures that the gas does not escape past the bullet, which, moreover, may be imagined as moving so easily and so rapidly that the gas has scarcely time to get ahead of it.

The races, or grooves, in which the balls revolve at the breech end extend back to the powder chamber, the projectile lying so that its head just engages with the first ball in each groove. At the muzzle end the grooves are closed with what the inventor terms recoil cushions, the twist of the grooves ceasing for a short distance from the muzzle in order to admit of their insertion. These cushions are constructed either with glycerine or with steel springs, but, whichever device is used, matters are so arranged that the compression transmitted along each row of balls begins as soon as the projectile enters the bore and is complete as it leaves the muzzle. In this way the inventor claims that recoil is done away with; the bullet has a course so open and free from resistance that the initial recoil is very small, and what there is is taken up by the recoil cushions, the tendency of the bullet being rather to drag the gun after it than to kick it away behind it.

In regard to performance, the inventor states that he gets 30 per cent. greater average velocity, penetration, and range than can be obtained with the same weight of projectile and



Sections showing Rifling and Ball Bearings.

charge in guns made on the old system. His ·303 gun has a muzzle velocity of 3200 foot-seconds, and a point-blank range of 650 yards, compared with the 450 of the British service rifle of the same bore, using exactly the same charge, and, while the latter can drive its bullet through 72 one-inch boards, the Cullen gun can penetrate 116. The Cullen gun of the same calibre is 6 ins. or 7 ins. shorter, though its weight is about the same, because the barrel is thicker, and its rifling makes four complete turns, against three in the Lee-Enfield. The balls used in the grooves of a rifle of this calibre are one-tenth of an inch in diameter; in a 4-in gun they are three-quarters of an inch.

Another advantage claimed for the gun, due to the comparative absence of friction between the bullet and the ball bearings, is that the barrel does not heat; so markedly is this the case that with Maxim guns it is said to be possible to dispense with the cooling jackets which have given so much trouble in Tibet. The absence of recoil (which, however, can be obtained by contracting the bore, if it is wanted for any reason, as for working the Maxim-firing mechanism) again has important consequences, since it does away with the necessity for complicated carriages and mountings intended to take up the recoil. Mr. Cullen has a six pounder which he fires regularly with no more elaborate mounting than a block of wood, and he claims that his guns, except when they are so heavy as to require mechanical appliances for training, could quite well be used with the antique gun-carriages which now serve no more useful purpose than to afford a picturesque decoration to some of our public places. Ships, too, should no longer need to have their structures specially strengthened in order to withstand the strains set up by the firing of their ordnance.

REVIEWS OF BOOKS.

Radio-Activity.—Three books have recently been published on radio-activity and the properties of radium: and of these three, that written with the title of "Radio-Activity," by Professor Rutherford, D.Sc., F.R.S. (Cambridge: University Press), may be taken as the standard work on the subject. To Professor Rutherford more than to any other one person is to be ascribed the proof of the disintegration theory of radium; and the demonstration that the rays and the emanations which are characteristic of radio-active substances are merely symptoms of the decay of the elements. We use the word "proof," though the proof is far from complete, and the inferences which Professor Rutherford draws from the properties of the α, β, and γ rays of radium, or from the conversion of the gaseous emanation of radium into helium, are still disputed by many chemists. If the inferences which Professor Rutherford draws are the right ones, then we should expect nearly all substances to be more or less radio-active. Professor J. J. Thomson, at the recent meeting of the British Association, declared that, in his opinion, they were so: and though Professors Elster and Geitel, whose work in radio-activity entitles them to the most respectful hearing, did not accept all Professor Thomson's conclusions, it is hard to see how they are to be refuted. As Sir Oliver Lodge has remarked, if we accept the electric theory of matter, then one might almost say that there is no need to *prove* the radio-activity of ordinary matter, for the burden of proof should rather lie on the shoulders of opponents of this view, who must show that it is *not*. If we are then to take the most generally-accepted view of the reasons for the phenomena of radium, a view which is now accepted by one of the greatest of the earlier sceptics, Lord Kelvin, we must allow the views put forward in Professor Rutherford's "Radio-Activity" to be the only ones that can endure the test of examination. They are, in a nut-shell, that all the phenomena of radium are caused by the splitting up of the atoms of which radium is composed, and their dispersal as electrons, or as new combinations of electrons. The alternative view that there was something in the constitution of radium's molecules or atoms which enabled it to draw supplies of energy from the surrounding ether, or from some other unknown sources of energy, has been declared by Sir William Ramsay to be supererogatory. Among the special features of the book are the historical treatment of the discovery of the various phenomena of radium: The heat emission (MM. Curie and Laborde): the β rays: Sir William and Lady Huggins's spectroscopic researches: a discussion of the possible origin of polonium; and a full account of the results obtained by Sir William Ramsay and Mr. Soddy in the production of radium emanation from helium.

Mr. Soddy's book, "Radio-Activity" (the "Electrician" Publishing Company), bears to Professor Rutherford's larger work much the same relation that Puckle's "Conic Sections," which was sometimes called Puckle's "Salmon," bore to Dr. Salmon's classic volume. This, however, is hardly fair to Mr. Frederick Soddy, who is an investigator of great brilliance and a writer of uncommon clearness, modesty, and perspicuity. He describes in the most admirable way the experiments in which he has been associated both with Rutherford and Ramsay, and his book, while not as exhaustive as that of his former colleague, puts in a concise form the speculations and conclusions to which the experiments gave rise. There is at the end of his book a chapter called "Anticipations," which in its title, if not in its subject matter, is perhaps a little rash, but, as Professor Horace Lamb has said, "even in mathematics something must be risked," and Mr. Soddy's speculations on the vistas which it has opened to our eyes by radium are interesting to the point of enthralment.

The third book which we have to include under this notice is "Radium," by Leonard A. Levy and Herbert J. Willis (Percival Marshall and Co.): but in so including it we are bound to confess that we do it something more than justice. It is not a text-book, nor yet is it quite a popular work in the style of "Radium-and-all-about-it," but a something between the two. To those who wish to get a general view of radium's properties, sufficiently accurate, and not at all heavy in composition, we may recommend it as a preparation for more substantial works.

The History of Painting in Italy.—The full title of Crowe and Cavalcasselle's incomparable work, the first two volumes of which have just been re-published by Mr. John Murray, and the remaining four of which, edited by Langton Douglas and the late Arthur Strong, are to follow in due course, runs "A History of Painting in Italy, Umbria, Florence, and Siena, from the Second to the Sixteenth Century." But the substitution of one substantive for another is justified by the fact that the history which Sir Joseph Crowe was assisted by Signor Cavalcasselle to compile, remains now, as it was then, distinctively and unalterably *the* history of the evolution of the painter's art in Italy. As Mr. Langton Douglas incontrovertibly remarks, notwithstanding all that has been done in the last forty years, by archivists on the one hand, and by connoisseurs on the other, with the object of elucidating the history of the central Italian Schools, this book continues to be the standard authority upon the subject. It is in one sense more than that. It is one of the few books of scientifically accumulated facts, of which it might be said that an English work is the admitted European authority. In the collection of "co-efficients" on which to base theories the Germans are apt to beat us. This work has all the laboriousness of German effort without any of the repellent appearance of it; it is, in short, a work of art as well as a monument of human learning. It is encumbered with few of those theories which are accounted precious in one generation only to be forgotten in the next; but to the student who considers art from the point of view of its evolution, it presents all the raw materials for theory. If ever there should arise some Darwin among the historians of painting—which perhaps the painters might pray heaven to forbid—he would find no other work than this by which he might trace the gradual evolution of a style or a method: the tendency to variability could be illustrated from these pages: the mutations arising from the accident of genius could be dated and their influence assigned. This is, however, to let one's imagination run away with one to an extent that would have been severely discountenanced by the authors, whose practice it was to admit no fact that had not borne the test of the severest scientific questioning; and we may fitly conclude this notice of a famous book by the statement of the necessary facts concerning the new edition. The original edition, now quite out of print, and very rarely to be bought, and only at a great price, was enriched with few illustrations. Its unique exactness and comprehensiveness was its sufficing recommendation. The new volumes are illustrated with all the resources of modern photography. Sir Joseph Crowe's additions to the first four volumes, amounting almost to rewriting, have been incorporated: and to the original text most valuable notes by Mr. Langton Douglas and Mr. Strong have been added in smaller type. The first two volumes are "Early Christian Art" and "Giotto and the Giottesques." The Sienese School, the Florentines of the Quattrocento and Cinquecento and the later Sienese and Umbrians will follow.

The Classification of Flowering Plants.—Dr. Albert Rendle's task in the latest volume of the Cambridge Biological Series, "The Classification of Flowering Plants" (Cambridge University Press), is to present to the student the considered results in classification which are afforded by the latest research in systematic botany. This, the first volume, deals with the Gymnosperms, pines, cedars, spruces, &c., and with the Monocotyledons, the lilies, grasses, and palms. The Dicotyledons will appear in the second volume. Historically, the general introduction is of the greatest interest, for here is to be found a clear comparative summary of the successive schemes in which Linnæus, Jussieu, and the De Candolles sought to express the resemblances and relationships of the flowering plants. Dr. Rendle has done something more than present summaries of these classifications; his method of presenting them is an essay in comparative criticism. In the rest of the book Dr. Rendle adheres to the most generally-accepted models of classification. That of the Gymnosperms includes the latest palæontological discoveries of Drs. D. H. Scott and Oliver. In discussing the Monocotyledons, the arrangement of Dr. Engler is the one to which he adheres. There may be some difference of opinion in respect of the nomenclature adopted in the classification of the Monocotyledons; but of the value of the work as a standard text book there can be but one opinion. It is extremely well illustrated.

British Mosses.—The declared object of the first edition of "The Student's Handbook of British Mosses," by H. N. Dixon and H. G. Jameson (Sumfield, Eastbourne; Wheldon, London), was to provide a practical handbook to the mosses of these islands in such a form as to be accessible to students; and we are pleased indeed to see that after eight years this modestly stated ambition has been rewarded by the call for a second edition. It is a reward far from immodest for a book which is in the highest degree useful, not to say indispensable, to the student; and which is compiled with a wealth of care such as perhaps would be taken by no one but the painstaking race of botanists for whom the consciousness that genius is the capacity for taking small pains must be a frequent, and, we hope, a not altogether barren consolation. Since the publication of the first edition some thirty species or sub-species have been added, together with a corresponding number of varieties of greater or less value. Recent research has added more precise knowledge of older varieties and has sometimes made changes in nomenclature necessary. It has not been possible to interpolate these additions to knowledge bodily in the volume without some alteration in its arrangement; but the changes that have been made in a classification, with which the authors had every reason to be satisfied, have been made with extreme care. The authors believe that such as are made will be found to be improvements, a belief which criticism may endorse.

Electro Chemistry.—To the series of text books on Physical Chemistry (Longmans, Green) to which Sir William Ramsay wrote the general introduction, Dr. Lehfeldt has contributed the volume on "Electro Chemistry." This volume deals with the theoretical side of the subject only; the application of the theory to the practical consideration of primary and secondary cells, to electrolysis, and to the solution of chemical problems is to follow. The relation between quantity of electricity and quantity of chemical action is elucidated in a chapter ranging from the consideration of Faraday's laws of electrolytic deposition to the Arrhenius theory of dissociation and its corollaries in respect of the conductivity of mixtures. The relation between electric intensity and the intensity of chemical action follows as a sequence to the first, and considers the theories of concentration, polarisation, &c., under the comprehensive heading of the theory of chemi-electromotive force. A chapter which the preface obligingly states can be missed by those who are not interested in pure chemistry, but which will probably not be missed by anyone who desires to keep in touch with the modern theories of chemical solution, is interpolated by Mr. C. S. Moore, on the relation of Chemical Constitution to Conductivity. The concentration of information in the text book is not its least noticeable feature.

Kinetic Theory.—In "Applications of the Kinetic Theory" (Macmillan), Professor W. P. Boynton endeavours to present the probable or possible relations to one another of the facts of electrolysis, of osmotic pressure, and the general phenomena of dissociation and solution, as seen by the light of the kinetic theory. In successive chapters, the kinetic aspect of ideal gases, of gases with molecules that have dimensions, of the conduction of electricity and heat; of vaporisation; of the behaviour of molecules within a liquid; of solutions; of dissociation and condensation, are dealt with. The volume is one of great suggestiveness to advanced students of physical chemistry, and though the author disclaims any originality of treatment, he displays judicial and selective powers of analysis and arrangement of the highest order.

Visceral Inflammations.—It has been said that there is a fashion in diseases; and in this casual observation there is the grain of truth that increased knowledge implies more precise classification of diseases ascribed loosely to causes and symptoms which may be merely incidental. Thus, as we are reminded by the papers and addresses which Dr. David B. Lees has collected in "The Treatment of Some Acute Visceral Inflammations" (John Murray), the knowledge which in the last twenty years has been gained of pneumonia, appendicitis, rheumatism, and the acute inflammations of the heart and kidneys, has resulted in an apparent increase of the number of cases classified under these heads. As an instance of what we mean, we may quote the cases of appendicitis, which for generations past have been ascribed to varying causes, many of them totally unfounded, but which are now grouped under the primary cause of an acute local inflammation. Similarly, the increase of knowledge in bacteriology has transformed the view taken of diseases such as pneumonia, and is throwing new light on many rheumatic affections. But the advance of treatment of these diseases has not kept pace with the advance of knowledge of their causes; and the treatises of those who, like Dr. Lees, have employed sixteen years of hospital work in the practical consideration of them, have the highest value, and are of the highest interest inside and outside the medical profession alike. It is, of course, as a text book of medical treatment that such a volume is compiled; but we have no hesitation in according it notice in columns which are chiefly intended for the review of general scientific literature. Its chief contents are lectures on carditis, pneumonia, empyema, pleurisy, appendicitis, and nephritis, with other papers on heart affections, their connection with rheumatism, especially in children; and some of the heart symptoms which follow influenza.

Common Animals.—Among the many good points of "The Natural History of some Common Animals," by Oswald H. Latter, M.A. (Cambridge University Press), is the extremely natural and logical way in which it teaches elementary zoology. Mr. Latter would divorce from elementary teaching of this subject the notion that structure must occupy the first, and almost the only, place in any method of study; and would impress on the minds of the instructed the necessity for learning function as well. In this way, as we believe, lies the best chance and opportunity of impressing on the mind of the young student a liking for the subject; and in impressing on his memory the relatively important details. Mr. Latter has thus chosen a few animal types as the best to suit his purpose, and has taught something about everything concerning them. The types selected are the Earthworm, Leech, Crayfish, Cockroach, Dragonfly, Wasp, Fresh-water Mussel, Snail, Slug, Frog, Toad and Newt, and some of the common internal parasites of domestic animals, and of these he has given a full biological and bionomical narrative. Of its kind this book is one of the best that has yet been written; its manner and matter are alike excellent.

Practical Geometry.—The "Practical Geometry for Beginners" (Macmillan and Co.), which has been compiled by W. L. Neve Foster and F. W. Dobbs, is based on the sound logic that the best way of preparing the youthful mind for theory is to suggest to it concrete values of lines, angles, perpendiculars, radii, and all the other furniture of geometry. Thus the book teaches geometry with the box of mathematical instruments, and a triangle no longer remains a symbol A B C or D E F, but is something tangible, measureable, comparable. This is but a hint of the method which eventually proceeds to the practical verification of theorems and laws, and which may be commended as practically useful and educationally interesting.

Technical Thermometry.—The Cambridge Scientific Instrument Company sends us a copy of their list on "Technical Thermometry," together with an intimation that the lists can be obtained from them, on application, by readers of "Knowledge." The list is a summary of the latest methods and appliances in electric thermometry; and, apart from its use to students, it is of instructional value in defining the practical applications of electrical thermometers in annealing furnaces, in boilers and superheaters, and in explosive sheds. The thermometer, and, above all, the exactly and instantaneously recording thermometer, has become, in recent years, of the utmost importance to chemical works, to the brewing industry, and to engineers and manufacturers in increasing numbers. The catalogue before us is a summary in brief of the instrument's use and practice.

The new catalogue of Messrs. Isenthal and Co.'s Electric Heating Apparatus forms a not uninteresting record of the various uses to which any householder can turn the electric current supplied to him from the mains. For readers of "Knowledge" the list is chiefly of service in detailing the uses to which electric heating apparatus can be put in the laboratory or the hospital, but the limits to the purposes to which electricity can be applied in the dwelling house, the kitchen, the workshop, and the factory are becoming enlarged every day.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Coccidae.

With Notes on Collecting and Preserving.

By Alice L. Embleton, B.Sc.

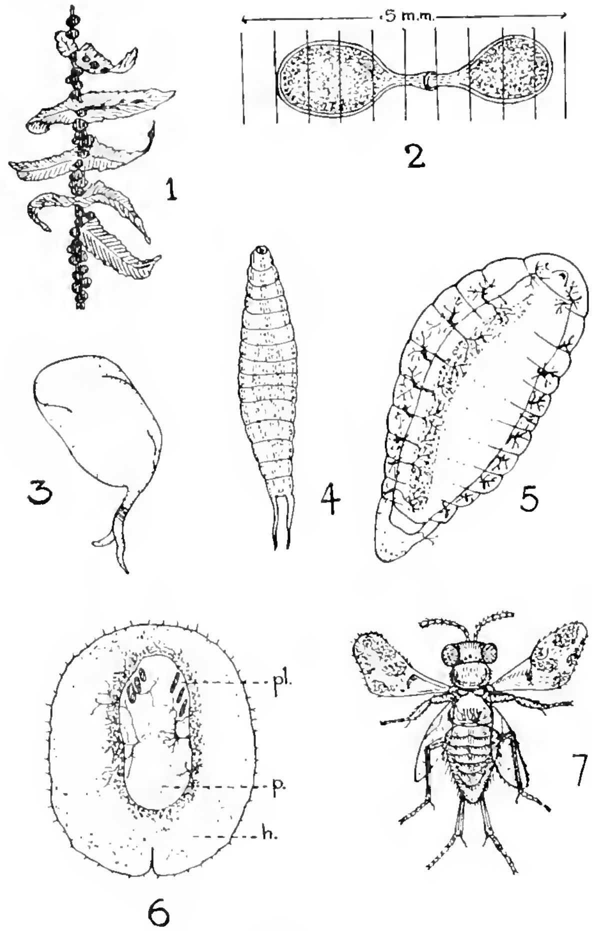
(*Continued from page 224.*)

As regards the possible introduction of the San José into Europe, there is little cause for alarm, for the climatic conditions and the character of fruit-growing in this continent would make it hard for this scale ever to become a serious factor here.

In the West Indies enormous damage is done to crops of all kinds, and yet it is only within the last decade of the 19th century that attention has been paid to scientific work on economic entomology. The sugar-cane pests in particular are responsible for a heavy, regular loss to the planters; investigations are now, however, being carried on with a view to finding remedies and controlling methods.

It is best to begin with measures of quarantine against the introduction of new diseases. Preventive measures ought to be adopted, for it is of enormous importance if an outbreak of a disease can be avoided, and it is only by a knowledge of the life-histories of the pests that an attack can be predicted and controlling conditions set up, such as, for example, alternation of crops and trap-crops. If, however, the insect is already established, then suitable remedial measures must be applied, either by the direct use of poisons, or by the indirect control through the presence of enemies to the injurious insect. Fortunately for the horticulturist, *Coccidae* have innumerable enemies, and the problem of their control is largely solved by the action of checks provided by Nature, such as birds, lizards, bats, etc. Apart from these there are the multitudes of insects that prey upon *Coccidae*, either as predators or parasites; these tend, in a state of nature, to keep the balance right, but this equilibrium becomes much upset by the artificial conditions set up in cultivated countries where it is impossible to avoid this disturbance of the influence of natural checks.

The *Coccidae* are hosts for numerous minute insect parasites, as well as being food for the predaceous ladybird beetles (*Coccinellidae*), which are among their most important natural enemies. Among the many thousands of minute Hymenopterous insects in the world to which have been given the popular name of "Chalcid flies," there is probably no single family that is of more interest and importance from an economic point of view than that of the *Encyrtidae*. The various species composing this family, like the vast majority of Chalcid flies, live parasitically in the eggs, larvæ, pupæ, and imagoes of other insects, and hardly a single order of six-legged insects is wholly free from their attacks. But in this family, and more especially in the sub-family *Encyrtinae*, the species are of more particular interest and importance for the economist, since so many of them are found attacking and destroying *Coccidae*. The work on the development and life-histories of these small creatures is of necessity very minute, seeing that the hosts are usually only one or two millimetres in length in the adult condition; and yet little can be done in the matter of encouraging these beneficial creatures unless their life-cycles are well known. Much of the work demands special methods for the microscopic preparations. To illustrate this we may take the well-known brown scale on ferns and



EXPLANATION OF FIGURES.

Fig. 1.—Portion of Fern-frond attacked by *Lecanium hemisphaericum* var. *filicum*, the Coccid being parasitised by *Comys infelix*.
Fig. 2.—Egg before separation of the two masses.
Fig. 3.—Egg after losing the yolk-mass.
Fig. 4.—First observed larva with bifurcated tail. Length, ·75 mm.
Fig. 5.—Larva showing spiracles.
Fig. 6.—Prepupa in situ in the host, inverted position. *h*=host; *p*=parasite; *pl* plates.
Fig. 7.—*Comys infelix*, ♀, dorsal view. Length, 2·5 mm.

Drawn by F. Shillington Scales after drawings by Miss A. L. Embleton.

palms (*Lecanium hemisphaericum*), which is parasitised to an enormous extent by a minute Encyrtid (*Comys infelix*). On a fern frond that has, say, 200 *Coccidae* upon it, at least 190 of these will be killed by the *Comys*. The female of this little fly measures 2.5 mm. in length, and is black, with fuscous patches on its wings. It is very curious that the male is extremely rare, for whereas the females occur in myriads, the males have only once or twice been obtained. In many ways the life-history of this fly, as far as at present known, is extraordinary and unique. The newly-

hatched female is found to have ovarian tubes in which are eggs in various stages of development. The youngest appear as oblong protoplasmic masses in the tube; later each of these masses in the chain becomes constricted in the middle; this becomes more accentuated, until the egg assumes a dumb-bell shape, the two parts being connected by a narrow neck, on which there is a curious papillated valve or lip. Before this egg is laid in the Coccid host, one division disappears, so that the egg as found in the host is an oval body with a stalk which is found to run to the surface of the host's carapace, where its mouth is plugged with some dark substance. The position of the parasite egg is constant, being always dorsal and posterior, a little to the left. In an allied form, *Encyrtus fusicollis*, Professor Marchal, of Paris, has found that each egg gives rise to upwards of a hundred embryos—the host being a caterpillar.

The larvæ of *Comys infelix* passes through various curious and complex conditions, peculiar chiefly for the means it adopts for breathing; the most startling being that of the prepupa, where the host tracheæ appear to be themselves utilised and connected with the parasite spiracles, and respiration goes on with the aid of these borrowed tubes. Another curious feature is that the prepupa seems to evolve a modification of the Malpighian tubules of the larval form, and to get rid of its spare uric acid in sacs containing rosettes of red uric acid crystals, these sacs being applied to the sides of the parasite's body, and left behind on the old pupal skin when the fly escapes.

(*To be concluded.*)

Newton's Rings in Microscopical Objectives.

A Correspondent sends the following note:—

"The modern method of testing optical curves on glass to ascertain that they are accurately formed is by means of what is known as proof plates. These proof plates are made of glass, having ground and polished in them the precise curve required. When the lens is finished, the proof plate is put in contact with it, and if the two are coincident—*i.e.*, the two surfaces of the lens and the proof plate respectively make optical contact—coloured rings, known as Newton's Rings, will be seen.

"For immersion objectives used on the microscope, the full power of the objective can only be developed when specimens are mounted either in a medium of suitable refractive index, or are actually adherent, and in optical contact with the under side of the cover glass. If a slide of the diatom Pleurosigma angulatum be searched over with a lens, say, of ½-in. power and a deep eyepiece, specimens will be found on which coloured rings—some round, some elliptical, others of a nondescript shape—will be seen, and it is in the centres of these appearances that the frustule, or a portion of it, is in optical contact with the cover glass. Having located this position, if an oil immersion objective be used, immensely superior definition will be found to be obtained at this point of optical contact than can be secured on other parts of the diatom which may not be so close to the cover."

Cleaning Oil-Immersion Objectives.

Dr. Henri Van Heurck calls attention to the advantage of using saliva as a means of cleaning oil-immersion lenses. He first cleanses the objective and slide with a piece of old dry linen of fine texture, then moistens an end of the linen with a little saliva, and gently rubs the objective front with it, using a magnifier to see if the cleaning is perfect. Owing to the slightly alkaline nature of the saliva the cleaning is perfect, and practically instantaneous; and Dr. Van Heurck says he has used this method since 1878, and has never found it to fail, whilst it keeps the front of his objectives as clear as when new.

Popular Microscopical Lectures.

I have received the annual list of lectures proposed by the Extension Section of the Manchester Microscopical Society for the ensuing winter. The scheme is so admirable and so well arranged that it deserves more than a mere reference. Briefly, some 54 different lectures, selected from the infinite variety of subjects dealt with by the microscope and illustrated mostly by lantern slides, are arranged to be given by some 20 members of the foregoing Society. They are given to outside associations of all kinds who make the necessary application, and, except in cases where such associations are supported out of public funds or are commercial speculations, are given free of charge other than the reimbursement of actual out-of-pocket expenses. The result is the bringing of scientific knowledge and information before those who would be unable to pay large fees to professional lecturers, and the extension of the knowledge of microscopy and natural history. Nowadays the microscope, whilst becoming daily more and more necessary to the professional, finds many competitors for favour with the amateur, and lectures of the kind arranged by the Manchester Microscopical Society should bring home to many the fascination of the microscope as a recreative as well as educational instrument. It would be well if the Quekett Club could see its way to adopt a similar scheme; in so large a district as is embraced by the Metropolis there should be no lack of applicants for the services of its lecturers, and the result could not fail to be of benefit to microscopy, and, incidentally, to the Club itself.

Notes and Queries.

Wm. Watts, Bristol.

Total length, ·055 to ·06 mm. Head, ·0045 mm. long, ·0025 mm. broad, ·0015 mm. thick. Middle piece or body, ·006 mm. long and less than ·001 mm. in diameter. Tail, ·045 mm. long and finer than the middle piece.

J. M. Dunbar, East Griqualand.

I am sorry that I do not know of any good book dealing with the microscopical examination of adulterated foods. Such an examination is really a matter for the specialist, and the microscopical examination would be only part of a wider examination, chemical and otherwise. If you can read German, perhaps Dr. Herman Hager's "Das Mikroskop und seine Anwendung," published in Berlin, might serve as an introduction. It could be obtained from Williams and Norgate, Covent Garden, London, for about seven shillings and postage. I wonder if any of my readers know of any other book?

Microscopical Material.

Mr. W. S. Rogers has kindly sent me for distribution a quantity of capsules of *Funaria hygrometrica*, the peristomes of which make very beautiful dry mounts, and are curious owing to the changes they undergo when wet and dry respectively. I shall be glad to send a few of these to any reader enclosing a stamped addressed envelope together with the coupon appearing in another part of this issue. In case the lids have not been shed they may be removed with a fine needle, but great care is requisite.

[*Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for October.

By W. Shackleton, F.R.A.S.

The Sun.—On the 1st the Sun rises at 6.1, and sets at 5.37; on the 31st he rises at 6.53, and sets at 4.34.

Sunspots, faculæ, and prominences are fairly numerous.

The positions of the spots, &c., with respect to the equator and poles may be derived by employing the following table:—

Date.	Axis inclined from N. point.	Centre of disc, N of Sun's equator.
Oct. 1 ..	26° 11′ E.	6° 38′
,, 11 ..	26° 29′ E.	6° 2′
,, 21 ..	26° 2′ E.	5° 15′
,, 31 ..	24° 49′ E.	4° 17′

The Moon:—

Date.	Phases.	H. M.
Oct. 2 ..	☾ Last Quarter	1 52 p.m.
,, 9 ..	● New Moon	5 25 a.m.
,, 16 ..	☽ First Quarter	5 54 a.m.
,, 24 ..	○ Full Moon	10 56 a.m.
,, 31 ..	☾ Last Quarter	11 13 p.m.
Oct. 8 ..	Perigee	6 6 a.m.
,, 20 ..	Apogee	2 6 p.m.

The only occultation of the brighter stars visible before midnight is that of 96 Aquarii, magnitude $5\frac{3}{4}$, at 7.49 p.m. on the 20th.

The Planets.—Mercury is a morning star in Virgo; he is at greatest westerly on the 1st., subtending an angle of 17°54′ W., when he rises nearly 2 hours in advance of the Sun. The planet is in superior conjunction with the Sun on the 31st.

Venus is an evening star in Libra, but is too low down in the S.W. at sunset to be suitable for observation.

Mars is a morning star in Leo, rising about 2.15 a.m. on the 15th.

Jupiter rises about sunset throughout the month, and forms a very conspicuous object in the sky, looking due E. about 7 p.m. The planet is in opposition to the Sun on the 18th, when the apparent equatorial diameter is 50″·4, whilst the polar diameter is 3″·3 smaller.

At 10 p.m. on the 23rd the planet is in proximity to the Moon, being only $1°\frac{1}{2}$ to the North.

The configurations of the satellites, as seen in an inverting telescope at midnight, are as follows:—

Day.	West. East.	Day.	West. East.
1	423○1	16	1○432
2	41○$^2_3$	17	4○$^2_1$3
3	4○213	18	421○3
4	42○3 ●	19	42⊙3
5	413○2	20	43○12
6	43○12	21	4312○
7	34$^2_1$○	22	432○1
8	234○1	23	41○32
9	1○3$^2_1$	24	4○123
10	○2134	25	21○43
11	21○34	26	2○134
12	○4⊙1⊙3●2	27	3○24 ●
13	3○124	28	312○4
14	312○4	29	32○14
15	$^2_3$○14	30	1○324
		31	○1234

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in he shadow. The numbers are the numbers of the satellites.

Saturn is suitably placed for observation in the early evening, being on the meridian about 7.30 p.m. and setting at midnight on the 15th. Throughout the month the planet is nearly stationary in Cancer; he is near the Moon on the evening of the 17th.

The ring is widely open and we are looking on the northern surface at an angle of 16°; the polar diameter of the ball is 16″·2, whilst the major and minor axes of the outer ring are 40″·8 and 11″·5 respectively.

Uranus is on the meridian about 4 p.m. and sets in the S.W. about 8 p.m., near the middle of the month. He is close to the star 4 Sagittarii.

Neptune rises about midnight on the last day of the month. He is situated in the constellation Gemini, as shown on the chart in the January number. The planet is in quadrature with the Sun on the 1st, and at the stationary point on the 11th.

Meteors:—

The principal shower of meteors during the month is the Orionids.

Date.	Radiant. R.A.	Radiant. Dec.	Characteristics.
Oct. 8-29 (18 to 20 maximum)	92°	15° N.	Swift, streaks.

The Stars:—

About 9 p.m., at the middle of the month, the following constellations may be observed:—

Zenith . Cygnus, Cepheus, Cassiopeia.

South . Pegasus, Aquarius, Capricornus, *Fomalhaut*.

West . Lyra, Hercules, Ophiuchus, Corona; Boötes to the N.W.; Aquila to the S.W.

East . Andromeda, Perseus, Aries, Pleiades; Auriga to the N.E.; Cetus to the S.E.

North . Ursa Major, Ursa Minor, Draco.

Minima of Algol may be observed on the 2nd at 5.14 p.m., 17th at 1.19 a.m., 19th at 10.8 p.m., and 22nd at 6.57 p.m.

Telescopic Objects:—

Double Stars:—γ Arietis $1^h 48^m$, N. 18° 48′, mags. 4·2, 4·4; separation 8″·8. Easy double, power 30; notable as being the first double star observed telescopically.

γ Andromedæ $1^h 58^m$, N. 41°·52′, mags. 2·1, 4·9, separation 10″·2. The brighter component is intensely yellow, whilst the other is greenish blue. The fainter star is remarkable for being a binary, the components of which are now less than 1″ apart.

Nebulæ:—

Nebula in Andromeda, easily visible to the naked eye, and readily found by referring to the stars β and ν Andromedæ. Seen with a 3 or 4 inch telescope, it appears to be an extended oval, which is in reality composed of spiral streams of nebulous matter.

(32 M.) Nebula close to the great Andromeda nebula, and situated about 2° to the south. It is fairly round, and appears somewhat like a star out of focus.

(18 ♅ v) lies about the same distance north of the great Andromeda nebula that 32 M does south; it is faint, but large and elliptical.

Knowledge & Scientific News

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CONTENTS.—See Page IX.

Indigo.

By Dr. F. Mollwo Perkin.

One of the oldest and most valuable of colouring matters is indigo. Its properties and use were known in India and Egypt many years before the christian era. It is described by Pliny, who says it was used as a paint, and from what he says it would appear that the merchants of his time were not very much better than some in our own days, because the indigo was often adulterated with chalk or the excrements of pigeons, and Pliny gives tests by which the pure product might be known. It was not until the 16th century that indigo was introduced into Europe. When it was first introduced, however, the sellers of indigo encountered great opposition, and it was not until considerably later that its use became at all general.

It was the cultivators of woad who opposed its introduction so violently; they contended that the dye was fugitive, and was also a pernicious and corrosive poison. So great was their influence and opposition

Fig. 1.—Indigofera tinctoria.

Fig. 2.—Isatis tinctoria.

that Henry IV. of France issued an edict in which it was made a capital offence to use or sell this pernicious drug, or devil's food, as it was called. There was also a statute in England which prohibited the use of indigo, and to this day that statute has, I believe, never been repealed. The interesting point about the opposition of the woad cultivators is that woad itself is a variety of indigo, and the blue dye with which the ancient Britons anointed their skin, in place of warmer clothing, was, in fact, indigo blue.

The indigo plant, *Indigofera tinctoria*, is shown in Fig. 1, the woad plant, *Isatis tinctoria*, in Fig. 2. As a matter of fact, woad is, to a certain extent, still grown in Lincolnshire and in the south of France and

Hungary. It is not generally used for dyeing *per se*, but is employed in the preparation of certain indigo vats.

The indigo plant is herbaceous, and grows to a height of from three to four feet, having a single stem about half an inch in diameter. The land on which the plant is grown is ploughed in October or November and sown with the indigo seed at about the end of March or the beginning of April. The plant is of rapid growth, and is cut for the first crop in about the middle of June to the beginning of July—if the weather has been propitious, usually at the earlier date. The indigo plant is cut when it is just mature, as indicated by the opening of the flower buds. After about eight weeks a second crop is obtained, but the yield of indigo is not so good as from the first crop.

Treatment of Plants.

We will not here describe all the different methods which are employed for obtaining the indigo from the plant, but will merely give an idea how the process is, in general, carried out. It must, in the first place, be understood that the indigo does not exist in the free state, *i.e.*, in the form of a blue dye, but is there as a *glucoside*—that is, combined with a kind of sugar called *indiglucin*, and this compound has first to be split up before the indigo can be obtained.

The indigo plants after cutting are tied up into bundles, and the bundles carefully and tightly packed into vats built of brickwork and lined with stone or cement. When the vat is completely filled with the indigo plant, beams of wood are wedged across the bundles and water is run in so as to completely cover the plant. The object of wedging the bundles down is to keep them below the water and to prevent them being forced out when they swell, after the water has been added. In a short time an active fermentation sets in, which generally lasts from 10 to 15 hours according to the temperature of the air and the condition of the plant. As soon as the fermentation becomes tranquil the liquor is run off into the beating vats. At this stage it varies in colour from a pale to a golden yellow—the darker the colour the greater the yield of indigo, but the light-coloured liquor, though yielding less, gives a finer product. In the beating vat the liquor is agitated by means of wooden paddles or shovels, which are worked by hand. (In many factories the beating is now done by machinery.) As the beating is continued the yellow liquor gradually changes from green to blue, and finally solid indigo begins to separate out. After the beating is finished the blue fluid containing the suspended indigo is run into the settling tank, where the indigo slowly falls to the bottom, leaving the clear liquid above. The supernatant liquor is then run off and the mud of indigo pumped up into a caldron and boiled. This boiling serves to prevent a second and destructive fermentation setting in, which would both spoil the quality and the quantity of the indigo; it also serves to wash it and remove impurities. After boiling it is run on to a large filter called the dripping vat, which may be from 20 feet long by 10 feet wide and 3 feet deep, the size, however, varies in different works.

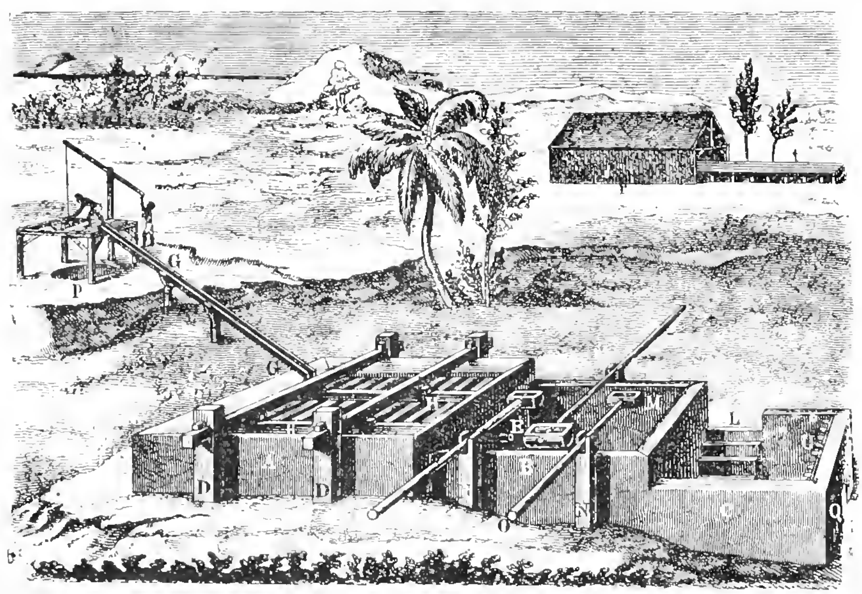


Fig. 3.

After draining for about 24 hours the pasty indigo is placed in perforated cloth-lined wooden boxes and is subjected to a gradually increasing pressure until no more liquid runs out. It is then cut into small blocks with a knife or brass wire, in much the same way that cheese is cut; the blocks being usually about 3 inches square. The cubes of indigo are then placed on a trellised staging covered with matting, which is contained in open sheds and dried by exposure to the air, direct sunlight being carefully excluded. The quantity of indigo obtained from each fermenting vat varies from 30 to 50 lbs.

Fig. 3 shows in a somewhat picturesque manner an indigo factory. A is the fermentation vat with the posts DD to hold the bars HH, which are employed to press down the bundles of the indigo plant. E is the pipe through which the fermented

liquor is run into the beating vat B. The beaters OM are held by the wooden fork N. C is the precipitating tank with the steps L, which are used for entering the vat to clean or empty it. Q is the outlet for the supernatant liquor. P is the well from which the water is obtained with the trough GG leading into the fermenting vat. V is the drying house in which the staging for placing the indigo is shown at t.

It has already been stated that the indigo is not found in the free state in the plant itself, but in the form of a glucoside called *indican*, which must be split up in order to obtain the indigo. This spliting up process is supposed to take place during the fermentation, but by the fermentation the indigo blue is not directly formed, a product called indigo white being produced. Now indigo itself is not a soluble substance, but indigo white is, and can be obtained from indigo blue by taking away part of its oxygen. When, then, this solution of indigo white is run into the beating vat and agitated, air becomes mixed with it, and from this it takes up oxygen, becoming converted into the insoluble indigo which is precipitated out.

As indigo blue or *indigotin* is insoluble in water, it follows that it cannot be used directly as a dye without being first made soluble. In order to dye with indigo it is first converted into indigo white by means of reducing substances—that is, substances which will take away a portion of its oxygen. It is to aid in the formation of indigo white that woad is added to the vat, because it helps to set up a certain kind of fermentation (butyric fermentation). A typical woad vat contains from 20 to 25 lbs. indigo, from 1½ to 5 cwt. woad, 20 lbs. bran or flour, 5 to 20 lbs. madder, and 24 lbs. slaked lime. The precautions necessary in preparing the vat cannot be entered into, but the operator must be skilful and experienced, the art of preparing the bath often being handed down from father to son.* When the vat is ready, which usually takes from two to three days, the wool or other goods are moved through the liquid for from 20 minutes to over an hour by means of a machine called a "hawking machine," they are then taken out of the vat and exposed to air, by which means the indigo white becomes oxidised to indigo blue.

Indigo blue is one of the fastest if not the fastest of blue dyes, and it is extremely stable to light and washing. The only fault it has is that it is apt to rub—that is, to colour other substances blue which are in contact with it, *e.g.*, the linings of dresses, &c. Very many attempts have been made to substitute other dyes in place of indigo, but it has always succeeded in holding its own, most other dyes lacking the rich hue and bronzy appearance produced by indigo.

A few years ago the Indian indigo manufacturers woke up with a start and found that there was an artificial indigo on the market—that is, an article which was made entirely by chemical means, and which was not dependent upon the growth of a plant. This artificial or synthetical indigo is made from products obtained from coal-tar and has exactly the same constitution and properties as the product produced from the indigo plant.

The manufacture of synthetical indigo is one of the greatest triumphs of chemical science. For more than 20 years German chemists had been engaged upon the problem of how to prepare indigo on a manufacturing scale. Professor von Baeyer had already in 1878 discovered what the constitution of indigo was, and had been able to prepare it in small quantities in the laboratory. But the problem of how to make it in quantity and cheaply took more than 20 years to elucidate, and the expenditure of enormous sums of money. Chemists all the world over were aware of the facts, but the indigo planters with a sublime indifference, unmindful of the fact that the great madder industry, and the manufacture of alizarine from this plant, had been abandoned owing to the advent of the coal-tar colour industry, went their way, treading in the old unscientific footsteps of their forefathers—we had almost said of the ancient Egyptians—until they were startled, as one of them picturesquely said, "by a bolt from the blue." Synthetical indigo was a reality.

As might be expected, there is a great deal of controversy as to the rival merits of natural and synthetical indigo. As a matter of fact, *indigotin*, the blue colouring principal of indigo, whether synthetically prepared or obtained from the plant, is exactly the same substance. But the indigo obtained from the plant is not pure, as it contains besides other impurities small quantities of indigo red, indigo brown, and a gummy substance called indigo-gluten, and the presence of these is said to impart a finer tone to the dyed articles. On the other hand synthetical indigo is quite pure, and the quality is always the same. The methods of the indigo planters have been unscientific in the extreme; now that the horse has been stolen they are locking the stable-door and have called in scientific advice. Improvements in the manufacture and better agricultural methods may, and probably will, postpone the final triumph of the synthetical indigo; but it is to be feared that this once flourishing industry will shortly be a thing of the past. It must be admitted that during the last six of seven years, since the introduction of synthetical indigo, the weather conditions have made it very difficult for the planters to obtain good crops, but even taking this into account the following figures, taken from a recent issue of *The Times*, are striking in the extreme. In 1894-5 there were 1,688,042 acres under cultivation for indigo; in 1902-3 the acreage had sunk to 574,054; the output of indigo had during the same period fallen from 237,494 cwt. to 73,908 cwt. For the five years, 1899 to 1900, the average export of indigo was 148,000 cwt. in 1903-4 it sank to 60,410 cwt., and the average price from 203 rupees for the *maund* (82 lbs.) to 148 rupees.

A good deal of the land, at one time under cultivation for indigo, is now being planted with sugar, and it is a matter of great importance for India that as the indigo is gradually forced out—we trust that the process may be a slow one—its place should be taken by some new product.

The subject of indigo cultivation and manufacture has been brought before readers of "Knowledge" in order to bring home the absolute importance of scientific knowledge and scientific research. If the Indian manufacturers had at the first sign of the appearance of synthetical indigo, in 1878, exerted themselves to understand the scientific problems underlying the production of indigo from the plant, we might not to-day see a waning industry. One has only to look at the wonderful progress of the beet sugar industry to see what can be done when chemical and agricultural improvements are carried on side by side.

* It must, of course, be understood that there are a great variety of methods employed in preparing an indigo bath, different baths being required for different kinds of work.

Modern Cosmogonies.

By Miss Agnes Clerke.

XI. The Procession of the Suns.

Phenomena are functions of time; and the form of the function has to be determined in each particular case. That is what the historical method comes to; and its use is prevalent and almost compulsory. We can no longer be satisfied with a simple bird's-eye view of the universe; our thoughts are irresistibly driven to grope into its past, and to divine its future. Static conceptions sufficed for our intellectual forefathers. They aimed at establishing the equilibrium of things, while we see them in a never-ending flux. One aspect of them calls up the next, and that another, and so on *ad infinitum*; we cannot, if we would, balance our ideas on the pivot of the transient present.

The immutable heavens of the ancients strike us to-day as the invention of a strange race of beings. We, on the contrary, see them with Shelley as a "frail and fading sphere"—a "brief expanse," the seat and scene of change. The "fixed" stars long ago broke away from their moorings, and began to flit at large through space. Of late, a less obvious, more intimate kind of mobility has been attributed to them. Grooves of individual development seem prepared for them, along which they shift as the tardy ages go by; and since everything that grows must decay, the orbs of heaven, too, incur the doom of mortality. Modern science, however, has done much more than extend to them the dismal philosophy of the phrase, "*tout passe, tout casse, tout lasse*." The grandiose enterprise has been not unsuccessfully essayed of tracing in detail the progress of sidereal evolution, and of marshalling the vast stellar battalions in order of seniority. This has been rendered feasible by the disclosures of the spectroscope. Apart from their guidance, the track might have been glimpsed here and there, but could never have been laid down with any approach to definiteness. Herschel found for it a *terminus à quo* in nebulæ of various forms, but attempted to pursue it no further. We do not hesitate to run it on, from station to station, right down to the *terminus ad quem*—not, indeed, without the perception of outstanding difficulties and insecurities. They appear, however, to be outweighed by a certain inevitableness of self-arrangement in the visible facts.

The argument from continuity is that mainly relied upon. An unbroken succession of instances is strongly persuasive of actual transition, provided only that a principle of development (so to call it) may reasonably be assumed as influential. A series of mineralogical specimens, however finely differenced, does not suggest the progressive enrichment of one original mass of ore. In the stars, on the other hand, a species of vitality may be said to reside. They are not finished-off products, but self-acting machines. They are centres of energy, which they dispense gratis, supplying the cost out of their own funds. And the process is not only obviously terminable, but must be accompanied by constitutional alterations, which might be traceable by subtle methods of enquiry. They *are* traceable, unless we are deceived by illusory appearances.

Secchi's classification of the stars was unwarped by any speculative fancy. It was purely formal; it aimed only at providing distinct compartments for the convenient arrangement of a multitude of differently characterised items of information. Then by degrees, the close gradation of one class into the next came to be noticed; the partitions melted away; the methodised array showed itself to be in movement; and the bare framework took shape, under the auspices of Zöllner and Vogel, as a cosmic pedigree. The white stars were set forth as the progenitors of yellow, yellow of red stars; and the insensibly progressive reinforcement of the traits of relationship between the successive types went far towards demonstrating some partial, if not a complete, correspondence of the indicated order with the truth of things. It has since been found necessary to divide the first stellar class into helium and Sirian stars; and here, too, essential diversity shades off imperceptibly into likeness approximating to identity. All the groups hang together; the entire scheme is on an inclined plane of change. Helium stars, as they condense, pass into Sirian, these into solar stars; which finally, reddening through the increase of absorption, exhibit the badge of post-meridional existence in fluted spectra. The finality of the red stage is, indeed, very far from being absolute, but what lies beyond is matter of conjecture.

There are several good reasons for taking helium stars to be the "youngest," or most primitive of the amazing assemblage that sparkle in the vault of heaven. The first is their affinity with nebulæ. Every star, perceived to be involved in folds or effusions of shining haze, has yielded—if bright enough for profitable examination—a spectrum of helium quality. Further, they are remarkably tenuous bodies. It has been ascertained with some definiteness, from the investigation of stellar eclipses, that helium stars are commonly, perhaps invariably, of far slighter consistence than the sun. Radiation, however, is maintained by contraction; hence, orbs at the outset of their course must be, on the whole, the most diffuse. A third note of youth is membership of embryo systems; and this is affixed very markedly to helium stars. One-third, certainly, probably one-half of those lately submitted to trial by Professors Frost and Adams proved to have spectroscopic companions. They are pairs believed to have been recently (in the cosmic sense) divided by fission. And this is an operation which must, we should suppose, be undergone early, or not at all.

The spectra of helium stars are peculiar and suggestive. Those belonging to Miss Maury's earliest groups—many of them visibly nebulous—bear next to no traces of metallic absorption, showing instead lines of oxygen, nitrogen, and of hydrogen in all its three series. The conditions, accordingly, needed to produce the "cosmic" modification of hydrogen are realised in these inchoate bodies. What those conditions actually are, we cannot tell; yet it may be confidently surmised that they will prove to be of an electrical nature. Hydrogen resembles the metals in being electro-positive; it collects at the negative pole during the electrolytic decomposition of water. There is, however, an unmistakable tendency in primitive sidereal objects to display absorption-rays of electro-negative rather than of electro-positive elements. It is conceivable that hydrogen may be capable of altering its behaviour in this respect; and that the molecules radiating the Pickering and Rydberg series, in addition to the more familiar Huggins series, have, in fact, through some corpuscular re-arrangement, assumed the electro-negative quality properly characterising a non-metallic substance. The association of this form of hydrogen

with oxygen and nitrogen in early helium stars could thus be more naturally related to the simultaneous quasi-disappearance from them of the spectral badges of metals.

The helium-line most distinctive of this stellar family is situated well up in the blue. It appertains to the same vibrational sequence with D_3, which is also represented, at any rate in Rigel, a somewhat "advanced" Orion-star. Here, too, we meet a fairly prominent magnesium-ray, lying below the blue helium emanation; while as yet iron is unapparent. Numerous fine, faint streaks, due to its absorption, emerge, however, when the Sirian type is fully reached, and they are mostly of the "enhanced" kind. When the spark-discharge is substituted for the arc as the source of illumination, certain lines in the resulting spectrum brighten relatively to the others; and these have been distinguished by Sir Norman Lockyer as "enhanced." Now, the rule is strikingly prevalent that the absorption-rays in white stars are of this class; yet it can no longer be interpreted as indicating for them an excessively high temperature. Rather, it would seem that electrical conditions, still imperfectly defined, are in question; and their gradual removal, or subsidence, is, beyond doubt, largely instrumental in bringing about the transition to the solar stage. The effacement of helium-absorption is even more perplexing. No sooner does iron begin to show than it vanishes. There is still a faint trace of its "blue" line in Vega; none survives in Sirius.

In spectra of the solar type, two great bars of violet light are stopped out by calcium; otherwise, metallic arc-lines predominate, while those of hydrogen are no longer so powerfully emphasised as in white stars. Moreover, the whiteness of the unveiled Sirian photospheres has become tinged with yellow owing to the development of a shallow envelope partly impermeable to blue rays. For this reason, the comparative extension of their ultra-violet spectra affords, for stars of different types, no secure criterion of relative temperature. Sound in principle, it becomes inapplicable when the unknown factor of general absorption comes into play. The energy-curve of the solar spectrum as it is, can be determined; the energy-curve of the solar spectrum as it would be if unaffected by general absorption, has to be constructed from inference. But only bare photospheres give congruous results. Hence, there are no valid grounds for asserting that Sirius is hotter than the sun, or the sun than Betelgeux. It may be so, but the evidence at present available is inconclusive. The appearances expounded in this sense may bear quite different meanings.

The reasons for holding that solar mature into Antarian stars are of the same nature, and of equal cogency with those tending to prove their own development from luminaries of earlier types. There is a similar continuity of specimens. They can be ranged one after another in an unbroken series, in which, as we descend the line, primrose shades into orange, and orange into red, general absorption arrests an increasing percentage of the blue radiations, while specific absorption becomes strengthened by dusky flutings of titanium. Carbon-stars are less easily located. Dr. Vogel regarded them as co-ordinate with the Antarian class. The two varieties of red stars with banded spectra descend, in his opinion, from the common stock exemplified by our sun. Professor Hale also favours this view, some attendant anomalies notwithstanding. His photographs have certainly established for carbon-stars links of relationship both with the Antarian and the solar families; yet the fact remains indisputable that the carbon type is, to a great extent, isolated from all the rest. Tokens of a genuine migration towards it are few and obscure.

The ultimate fate of both tribes of red stars can only be conjectured. Most vary in brightness, some to the verge of periodical extinction; and variability may be a symptom of interior dilapidation. The constitution, however, of such objects is still enigmatical. They appear to be exceptionally remote and inaccessible to enquiry. No indications have been gathered as to their density or intrinsic light-power. Very little is known about their movements. They rarely form binary combinations, and those that they do form are almost always relatively fixed. No red star travels in a computed orbit; only one, η Geminorum, occurs on the long list of spectroscopic binaries. The revolutions of this curious system ought to prove, when thoroughly investigated, of high interest and instruction.

Coupled stars offer special opportunities to students of cosmogony. They are obviously contemporaries; they have started fair; identical influences have acted upon them; hence differences in their standing can only result from dissimilarities in mass or composition. It is commonly taken for granted that a body containing less matter than its fellow must develop faster, and incur the final quenching sooner. But Sir William and Lady Huggins have adverted to the probability of the very opposite being the case. Powerful surface gravity may, they consider, serve to hasten the transition from a Sirian to a solar spectrum; and we should then have giant suns like Capella advanced in type while at a very early stage of condensation. This, perhaps, explains the remarkable spectral relations of contrasted stellar pairs. Always, so far as we yet know, the Sirian spectrum is yielded by the lesser star, the mass of which, judging by analogy, must be small even below the proportion of its faintness. It is true that the distribution of mass in binary systems is often widely different from what might have been anticipated. Certain purplish satellites, for instance, of undetermined spectral quality exercise a gravitative sway of surprising force. Some results of this kind, lately obtained by Mr. Lewis and others, are likely to prove of fundamental importance to theories of stellar evolution.

What we know of "dark stars" has been mainly derived from the observation of stellar systems. They are assumed to be the denizens of a stellar Hades, dim wanderers amid the shades, who "have had their day, and ceased to be" as suns. In the "cold obstruction" of these viewless orbs the grand cosmical procession is held to terminate. Their presence attests the downward progress of decay, and gives logical completeness to the argument for development. Yet there are circumstances warning us against too full an assurance that their status is really that of skeletons at the feast of light. They are very frequently found to be in close attendance upon brilliant white stars. Thus intimately, if incongruously coupled, they circulate, and compel circulation in brief periods, as members of systems just, it might be said, out of the shell. What are we to think, for instance, of the obscure body spectroscopically discovered to control the revolutions of the chief star in the Orion trapezium? It is evidently comparable in mass with that imperfectly condensed luminary; is it credible that it has already traversed all the stages of stellar existence, and cooled down to planetary rank? So violent an assumption

should, at any rate, not be made without due consideration; and we may more prudently hold our judgment in suspense as to whether globes so circumstanced—and they abound—should be regarded as effete, or as abortive suns.

Speculations on the exhaustion of stellar vitality have, however, lately become inextricably involved with the complex problem of elemental evolution. A dim inkling has been acquired of the working in the universe of obscure forces, availing, we can just see, to falsify many forecasts. The theory, at least, of the dissipation of energy needs important qualifications. Nor was it propounded by Lord Kelvin with dogmatic certainty. He carefully noted the possibility that in "the great storehouses of creation" reserves of energy might be provided by which the losses incurred through radiation could be, wholly or in part, made good.* The anticipated possibility is, perhaps, realised in the phenomena of radio-activity. But if we enquire how, we are met at the threshold by difficulties connected with the origin of helium. Helium appears to result from the disintegration of radium, its generation being accompanied by the setting free of enormous quantities of energy. Its copious presence, then, argues long-continued and lavish expenditure of heat and light. Yet it is as a constituent of highly primitive orbs that it is chiefly conspicuous. Gaseous nebulæ, too, include immeasurable supplies of it, while it is incompatible with whatever we seem to know about them to suppose that radium at any time entered into their composition. In truth, however, the genesis of the elements has not yet been made the subject of coherent speculation. Current ideas regarding it imply a double course of change, by aggregation first, and subsequently by disintegration. And this should give us a two-fold series of elements. On one side, there should be fixed survivals of the advancing process, on the other, products of decomposition, continuously evolved, and even now accumulating. If the claim of helium to take rank among these last should be finally established, our conceptions of the nature and history of nebulæ might have to undergo a strange inversion; but the outcome of the researches in progress is still uncertain, and may be far off.

It is, however, quite clear that the electronic theory of matter supplies no genuine explanation of the source of energy in the universe. What is given out when the atoms go to pieces must have been stored up when they were put together. Whence was it derived? This is the fundamental question which underlies every discussion concerning the maintenance of the life of suns. It is unanswered, and probably unanswerable.

* Thomson and Tait, *Natural Philosophy*, Appendix E, p. 494, edition 1890.

Physiology. Mr. E. H. Starling is to be congratulated on the little "Primer of Physiology" (John Murray). It is an attempt to convey with as few technical terms as possible the leading ideas which make up present-day physiology. That is rather a formidable task in a book of some thirty thousand words; but Mr. Starling not only does succeed in conveying a very clear idea of the way in which the normal processes of life are carried on, but does it without the sacrifice of any essential fact, and with—as for example in the chapter on serums—the illumination of the latest theory.

Rare Living Animals in London.

By P. L. Sclater, Dr.Sc., F.R.S.

III. Grévy's Zebra.

The herd of Grévy's zebra in the Zoological Society's Gardens in 1903, consisting of a male and four females, was, in my opinion, one of the finest groups of the class of mammals ever shown by the Society. Unfortunately, both the males have lately died, but an adult and three younger females still remain, and exhibit the form and markings of this beautiful animal—the most remarkable of all the living members of the Equine Family.

As to the perfect distinctness of Grévy's zebra from all the various forms known as Burchell's zebra and its other congeners there can be no longer any question. The larger size, broader ears, white belly, and entirely different style of banding render this splendid animal recognisable at first sight, as will be seen by Mr. Goodchild's drawing, which has been taken from the adult female of this species placed by her late Majesty Queen Victoria under the care of the Society in 1899, and still living in the Regent's Park.

Although probably well known to that most observant naturalist, Émin Pasha, who appears to have met with this animal in Latako in the Equatorial Province of the Sudan, the first specimen of Grévy's zebra to arrive in Europe was a living example, sent as a present by the Emperor Menelek in 1882 to M. Grévy, then President of the French Republic, and deposited in the Jardin des Plantes.* This was long before the "Fashoda incident," when France, in the eyes of the Abyssinians, was more potent than England. On hearing of the arrival of this novelty I hurried over to Paris to inspect it, and was rather disappointed to find the zebra already dead and an inhabitant of the Mammal-Gallery of the *Muséum d'Histoire Naturelle*. I saw at once, however, when I came to examine the specimen, that it was widely different from all other known zebras, although I had some little difficulty in persuading my friends at the Zoological Society that such was really the case.

In 1890† I was able to give the Zoological Society further evidence of the distinctness of *Equus grévyi* from the other zebras, and to show that its distribution extends from the southern frontiers of Abyssinia into Somaliland. A flat skin, obtained for me in Western Somaliland by Herr Menges, through the kind intervention of Herr Carl Hagenbeck, was found to belong unquestionably to *Equus grévyi*, which, in fact, appears to be the only zebra met with in that country. In his excellent work on Somaliland‡ Capt. Swayne gives us the following particulars concerning his experiences with this animal:—

"Grevy's zebra, although first described by the French, had been shot in Somaliland by Col. Paget and myself on our expedition of 1893. I found it at Durhi,

* See Proc. Zool. Soc., 1882, p. 721. The specific name *Equus grévyi* was based on this specimen by the late Alphonse Milne-Edwards (*La Nature*, No. 474).

† See P.Z.S., 1890, p. 443.

‡ "Seventeen Trips Through Somaliland." By Capt. H. G. C. Swayne, R.E. London, 1892.

in Central Ogaden, between the Fug Fafan and the Webbe, about three hundred miles inland from Berbera, and shot seven specimens. . . . . This zebra is very common in the territory of the Rer Va'alen and Malinger tribes. The country there is covered with scattered bush over its entire surface, which is stony and much broken up by ravines, the general elevation being about two thousand five hundred feet above the sea-level. The zebras which I saw (probably not more than two hundred in all) were in small droves of about half a dozen each, on the low plateaux covered with scattered thorn-bush and glades of *dura*-grass, the soil being powdery and red in colour, with an occasional outcrop of rocks. In this sort of country they are very easy to stalk. I saw none in the flats of the Webbe valley, and they never come so far north as the open grass plains of the Haud, Durhi, south of the Fafan, being, I think, their northern limit."

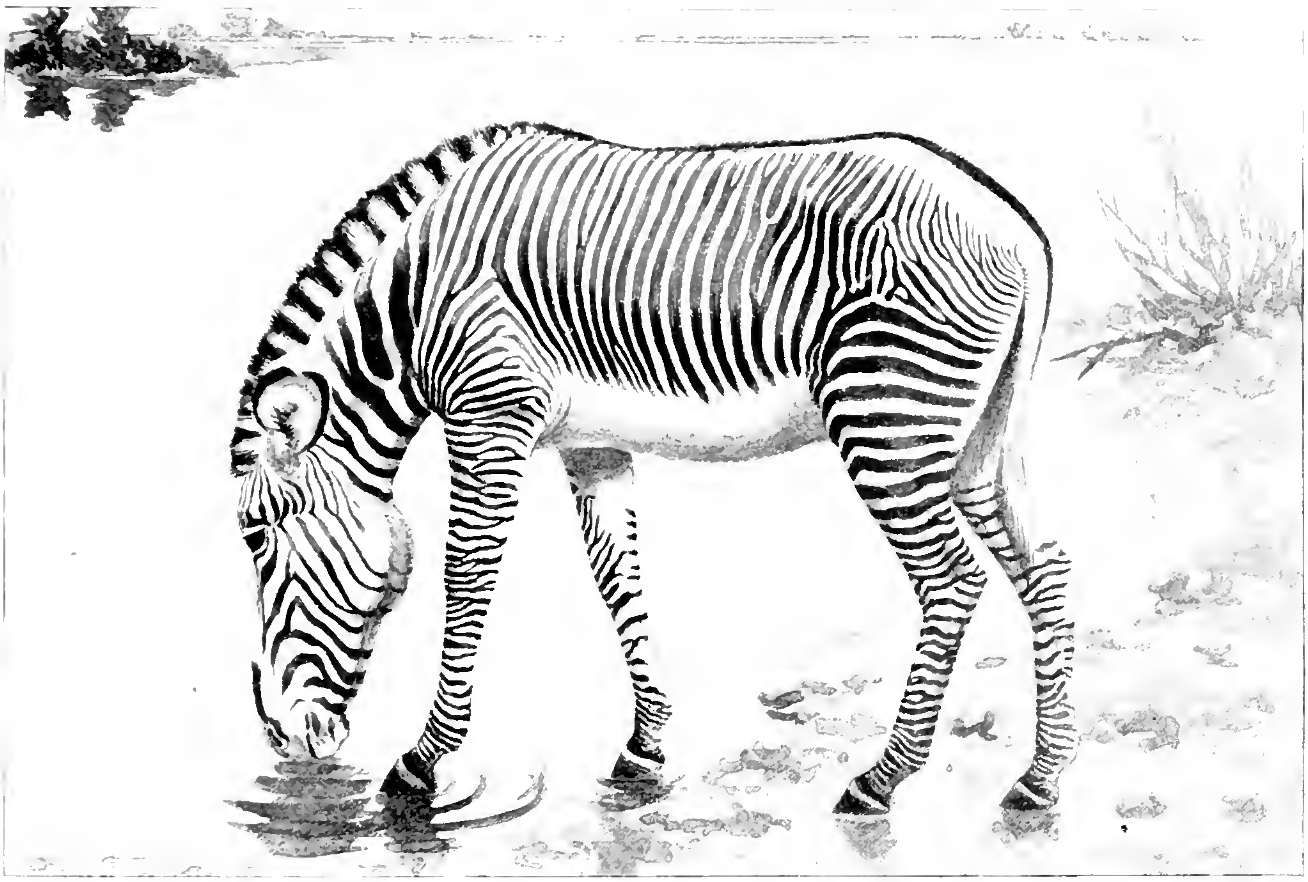
About the range of Grévy's zebra on the Abyssinian side, and whence the living animals sent to Europe by the Emperor Menelek were obtained, we have no such exact information. In 1895 the well-known American traveller, Dr. Donaldson Smith, gave us the following account of the distribution of Grévy's zebra so far as he was acquainted with it:—

"Commencing 20 miles east of the Shebeli River, the range of Grévy's zebra extends about 120 miles to the west; it is limited by the second and eighth degrees of latitude. On passing the Juba River you find Burchell's zebra in great herds among the mountains of the Boran country, but no Grévy's zebra until Lake Stephanie is reached. Here you find the ranges of the two species overlapping to a certain extent, but about Lake Rudolph I met only with Grévy's zebra."

It is probable, therefore, that the Grévy's zebras brought from Abyssinia were obtained from the country north of Lake Rudolph.

The Grévy's zebras exhibited in the Zoological Society's Gardens have been altogether six in number. The first pair, which were presented to Queen Victoria by the Emperor Menelek, arrived on August 14, 1899. The Emperor subsequently sent two females of the same zebra to King Edward, which were placed under the Society's care on July 12, 1902, and in the following year a fine young pair was presented to the Society by Lieut.-Col. Sir J. L. Harrington, K.C.B., H.M.'s Envoy at the Abyssinian Court. Both the males have been unfortunately lost, and the present stock in the Society's Gardens consists of females only. There are also one or more females of Grévy's zebra in H.G. the Duke of Bedford's menagerie at Woburn.

The form of the group of Burchell's zebras that extends furthest north, and is probably that which Dr. Donaldson Smith alludes to as in some places "overlapping the range" of Grévy's zebra is commonly called Grant's zebra (*Equus granti*). There is one example of this zebra also in the Zoological Society's Gardens at the present time.



Grevy's Zebra.

(From an Adult F... in the Gardens of the Zoological Society of London.)

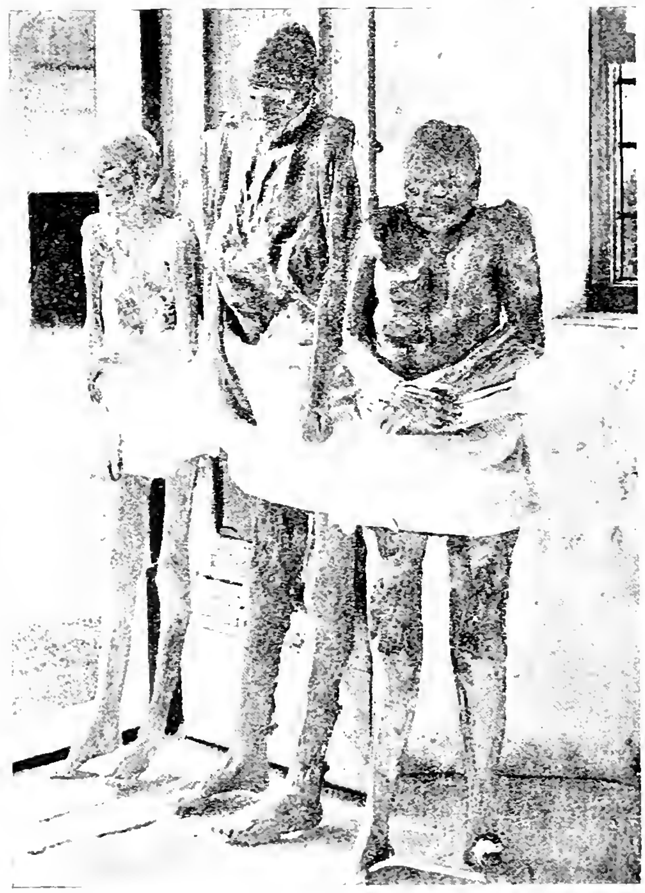
Natural Mummies.

By Frances A. Welby.

In the ancient parish church of Venzone, situated in the extreme north of Italy, some twenty miles above Udine, at the bifurcation of the valley known from time immemorial as the Canale di Ferro (long the high-road to Germany, and still to Carnia—up which, on the one hand, the railway passes to the Austrian Frontier at Pontebba, while, on the other, the historic River Tagliamento flows down from the Carnic Alps to the plain of Friuli) are thirteen tombs that possess the natural property of mummifying, or, more properly, desiccating, the bodies deposited in them. In the course of one year or less, more certainly in two, such bodies, clothed and placed in wooden coffins, are as a rule completely transformed, and become dry and light, and yellowish-grey in colour. The skin remains intact and resembles parchment; the bones are perfect, held in place by the dried ligaments and articular capsules, more or less covered with muscular and tendinous fibres, which, with the nerves and blood-vessels, adhere together in a desiccated mass. Teeth, hair (beard, eyebrows, eyelashes), and nails are all preserved in astonishing perfection, the fluid parts of the body alone disappearing. When extracted from the tombs, the mummies are covered with a layer of dark yellowish mould or fungus, that disappears little by little, and the cutis, at first blackish and flexible, becomes a pale yellow, in colour and texture exactly like sheepskin. They are extremely light in weight, varying from three to six kilograms.

The process is not effected with equal rapidity in all cases, and fails altogether in some instances (in which ordinary dissolution then takes place)—the reasons for this not having been discovered. The tombs in the church are twenty in number, but only thirteen, as said above, have this property of desiccation, and of these, again, seven succeed much better than the others. All are constructed with brick walls, cemented with common lime, and closed hermetically with slabs of stone or marble. It is, however, a curious fact that the process is not inhibited by the free admission of air and water, one of the most perfect mummies having actually been discovered floating in water. In dimension the tombs are about 1 metre 05 in depth, by 1.50 in width, and 2.00 in length. The inscriptions on the covers show that they belonged for the most part to ancient and noble families of Venzone, but three at the foot of the choir deserve special mention. The first held the remains of one Boleslaus, Duke of Schlesia, who had, perhaps, returned from the Crusades in the suite of the Emperor Conrad III., in 1149; in another rested Agostino, Prior of Brum in Moravia, and Bishop of Concordia, Vicar Patriarchal, who on June 22, 1392, was slain on the banks of the Tagliamento by Nicolò Savorgnan for complicity with the Patriarch in the murder of Federico Savorgnan, his kinsman; and the third must have covered a pilgrim, since the stone is inscribed with the words, *Hic jacet Laurentius de Brun*, and a rude sculpture of a hand holding a pilgrim's staff.

The first mummy was discovered in 1637, when, in rebuilding the Chapel of the Rosario, a sarcophagus inside the church (now standing outside the North door) was opened. Within it was found a coffin in good preservation, and within that a handsomely-clothed mummy also in good preservation. The tomb bears the arms of the Scaligeri, with two sculptured angels carrying away the soul of the departed. From its velvet wrappings, the mummy presumably belonged to this family. Unfortunately all the ancient records of Venzone were destroyed by fire in 1547, so that no previous documents exist to throw light on this, and, perhaps, earlier discoveries. The *Gobbo* (Hunchback), as he is called, is still preserved, and, like the rest of his companions, shows no sign of perishing from exposure, though he has suffered considerably from the rough handling of injudicious visitors. For many



years no more was thought of the phenomenon, until in the 18th century other similar mummies were discovered in other tombs, after which a number of successful experiments were made (eighteen up to 1831, twenty-one after that date), until burial in the church was prohibited for sanitary reasons. The last two were exhumed in September, 1901. The Venzonese frequently go to look at their relatives, and take pride in recalling familiar characteristics. The broken arm, e.g., of one of the latest subjects, is demonstrated with much satisfaction.

Napoleon I. visited Venzone in 1807, and proposed to make an Imperial Necropolis in the little mountain city, but upon his downfall the project was abandoned. Francis I. of Austria, in 1819, and Ferdinand I. in 1848, also visited this strange cemetery.

The thirty-two extant mummies are ranged round

the wall of an adjacent chapel, the ancient Oratory of S. Michael—a grim and ghastly company. From waist to knee they are clad in a decorous white kilt or loin-cloth, the ecclesiastics being somewhat grotesquely distinguished by birettas. Rosaries are still clutched in some of the poor desiccated fingers; the hands of one are clasped over his breviary. Women as well as men are there; the erstwhile notion that only the male sex were susceptible of mummification having been exploded by the discovery in 1820 of a very perfect female subject, who had died of typhus in 1810. The smaller number of female mummies is doubtless due to the fact that these tombs were usually reserved for priests and persons of distinction in the community.

It is notable that the phenomenon occurs not only in the parish church, but also in the Chapel of S. Catherine, a little to the east of Venzone, where is one tomb in which the remains become completely transformed, and where the body of Don Felice Lavoschi of Tolmezzo, the well-loved pastor of Venzone, who succumbed to cholera in 1855, is preserved to this day by the affection of his people. At Ospedaletto, too, three miles nearer Gemona, five similar tombs are known to exist in the ancient Priory of the Santo Spirito. And animal remains, in a perfect state of desiccation, have been picked up upon the plain of Portis, three miles above Venzone, on the road to Tolmezzo; so that it would appear as though for a radius of some six miles round Venzone, human and other animal remains, buried in the earth, or more particularly in the tombs of the churches, are in this singular manner more or less frequently converted into mummies.

The phenomenon has naturally given rise to much scientific discussion, though it appears still to be an unsolved problem. The latest writer, Dr. Paré (1870), exclaims with pardonable sarcasm that "had such a rare phenomenon occurred within 10 Italian miles of Paris instead of Udine, the French Academy would have appropriated it, would have subjected it to most searching examination, and would have published monographs of Atlantean magnitude, which, in proportion as they rose in price, would be treasured in the most illustrious libraries."

Dr. Ciconi in 1820 suggested that the desiccating agent might be the calcium sulphate, which, in a more or less anhydrous form, and mixed with calcium carbonate, constitutes the soil of Venzone and Ospedaletto. This comes from the limestone débris of the Carnic Alps brought down by the Fella and the Tagliamento. He points out that anhydrous sulphate of lime, which absorbs water avidly, was the principal substance used by Hunter in his celebrated process for preserving the human subject, and suggests that the imperfect desiccation occurring in some of the tombs would be due to their having been excavated above or below the beneficent layer. Marcolini in 1831 put forward a hypothesis that the acidification of the soil by hydro-carbo-phosphates might be the cause owing to which the natural processes of corruption were inhibited. Stringeri maintained the same idea a decade later. But Dr. Zecchini in 1861, and Dr. Paré (Director of the Hospital at Udine) in 1868-70, independently brought forward the theory that the desiccation was produced by a parasitic mould, *Hypha bombastica Pers*, which absorbs the aqueous humours of the body, and induces mummification. This mould is invariably present on the surface of the mummies, covering them here and there, in greater or less profusion, and persisting for a long while after their exhumation and exposure. But by previous observers it had been regarded as the *effect* and not as the *cause* of the phenomenon. It is a microscopic parasite, composed of white fungoid flocculi, analogous to the *Botrytis* or parasitic fungus that produces "*calcino*" in the silkworm. In 1870, Dr. Paré made a series of experiments in which he succeeded, by sprinkling various animal remains with Hypha from the Venzone mummies, in obtaining successful preservations of frogs, eels, and cats; while, on the contrary, he failed with fishes (apparently on account of the scales), and with a dead lamb (perhaps because the Hypha, nourishing itself upon the fatty humours of the wool, was unable to attack the body before it underwent decomposition). He explains the successes and failures in the human subject by the conflict between the Hypha or preservative agent and the processes of decomposition, the one or the other predominating according to circumstances. It is obvious from his experiments that the phenomenon is common to all animal remains, and is by no means peculiar to the human body.

Other similar mummies have been found in the Cathedral of Tolouse, in the Church of S. Michael in Dublin, and in the ancient Servite Monastery of Monte-all-Croce near Bonn; but they are less perfect than those of Venzone. A parallel has also been sought in the mummies found in the burning sands of Arabia, but at Venzone the phenomenon cannot be due to heat, as the temperature of the tombs is very low. Nor is it produced by the action of cold, otherwise the mummies would decompose at the temperature of the air, like those of the Arctic Regions. They are impervious to the action of air, and even of water; while the desiccating and preservative agent is able to resist even such potent forces as the putrefactive processes of typhoid fever.

NOTE.—The probable action of a parasitic fungus upon the "Venzone Mummies" is borne out by Mr. Massie's article in "KNOWLEDGE" for October, 1904, in which he mentions the *Botrytis*, by which the silk-worm is completely desiccated, or calcified—a too-familiar phenomenon in the silk-worm districts of Italy—and other forms of "mummifying" fungi.

Further information as to the probable cause of the phenomenon at Venzone would be welcomed by the writer, who failed, during a prolonged stay at Udine last year, to obtain any reliable scientific explanation of it.

Explosion of Stars.

By PROFESSOR A. W. BICKERTON.

Do stars explode? Are the observers of Lick and Yerkes correct when they said that Nova Persei had become a nebula that was expanding at such a rate that no theory of its origin was tenable, but that a star had exploded, been converted into gas, and blown at a velocity of thousands of miles a second to spread itself throughout the entire universe?

Is it conceivable, with the known laws of matter and energy, that a force can be generated great enough to blow a star to pieces? A calculation shows that were the entire star an explosive, it would have to be a score of thousands of times stronger than dynamite. Is there in Nature anything in which such a store of energy exists? This question must undoubtedly be answered in the affirmative, and the source of the energy is the attractive force of gravitation. The force with which the sun attracts matter, and the enormous

distance through which this force extends, gives us an energy so great that, without any original motion, a particle falling from the nearest star upon the sun would reach it with a velocity of three hundred and ninety miles a second. This velocity would possess an energy hundreds of millions of times greater than that of an express train, and the temperature produced by the stoppage of the motion would excel that of an electric furnace a score of thousands of times.

Hence, in the collision of suns we have an agent that may generate energy sufficient to cause the sun to explode, but so enormous is the mass of a sun, that the energy of collision has been shown to be too small to blow the sun into a nebula; but the probabilities of a direct, complete collision between suns is small indeed. Any original motion or any attraction of other bodies acting during their fall towards one another, would tend to make the impact of a tangential character, and it is upon the study of tangential impact that the solution of our problem depends. The velocity with which two suns would sweep past one another would be so great that a slight graze would not stop them. They would fly past one another, scarred by the encounter; but the portions that lay in one another's path, and that did actually come into collision would be swept from the remainder, would coalesce, and would form a new body in space. The tremendous motion would be converted into heat, and the mass of the new body, if the graze were not deep, might be so small that the explosive pressure produced would blow it into a nebula that would continue to expand with an enormous velocity, and every particle be finally dissipated into free space; in some cases leaving the very universe itself.

It is thus seen that the numbers and distribution of the stars must, on the demonstrated laws of Nature, produce an explosion; and it is highly probable that all the so-called temporary stars that have appeared at intervals in the heavens, usually increasing in brilliancy for some hours, or a day or two, and then gradually disappearing, are caused by partial impacts of stars or, in most cases, of dead suns. For all these bodies have similar spectra crossed with doubled lines, the one showing recession, and the other approach, indicating the two scarred suns that have struck one another; whilst the brilliant continuous spectrum seen in all new stars, for some time after the outbreak, is due to the mass of flaming gas that must expand at the rate of some million of miles an hour.

The velocity with which these bodies pass one another would cause the impact to be over in an hour or less; and in this time a body is produced with a higher temperature than that of any ordinary star. This brilliant body would soon expand until the globe of fire would be thousands of times the volume of the sun.

Hence we need not be surprised that Tycho Brahe's new star grew to be more brilliant than Jupiter, even more brilliant than Venus at quadrature; so intense, in fact, as to be visible at noonday. Nor need we wonder at its disappearance, for the flight of its myriad molecules all travelling from the point where the explosion occurred, would rapidly tend in their radial outrush to become parallel, and the molecules consequently cease to strike one another save at intervals; and as molecules only radiate immediately after encounters, it is obvious that, as these encounters become fewer in number, the luminosity of the mass would lessen and go on lessening until it was absolutely lost to vision.

Herschel has told us that the only possible explanation of the character of the many planetary nebula that he discovered was that they were hollow shells of gas. Every stellar explosion that is produced by a partial impact must result, at one stage of its history, in a planetary nebula that may be permanent or evanescent according to the attractive power of the new body as compared with its temperature.

Thus evanescent planetary nebulæ would be produced by slight grazes, whereas a deeper graze might produce a permanent planetary nebula, and still deeper grazes result in a large ratio of the molecules being attracted back, and producing a star in the centre of the nebula. Examples of this are comparatively numerous in the celestial vault.

So that our observers were doubtless right in the conclusion they came to that "Nova Persei" was a celestial explosion in which a star had been blown to pieces. And this fragment of the study of impact shows how important an agent impact is in astronomical evolution, for it must be remembered that all kinds of impacts may take place, from a mere graze up to a complete impact. Impacts may take place between dead suns or lucid stars. They may take place between meteoric swarms, or between star clusters. The impact of nebulæ may range from a mere graze through deep cuts, up to entire coalescence; and every form of impact save direct centre to centre must result in rotation, and obviously furnishes an explanation of the spiral character of so many thousands of nebulæ. Again, such vast bodies as the two magellanic clouds may be approaching one another, and after countless ages may impact, and should they strike deep enough into one another, coalescence of a whirling character would result, giving a galaxy of stars of a double spiral character, and spreading the poles of the ring with masses of nebulous matter, a configuration that exactly corresponds with the structure of our universe, and hence may we not ask the question, "Is not our visible universe a result of the coalescent impact of two previously existing universes, and if so may not such cosmic systems exist in endless number throughout the infinity of space?"

Such are the lofty conceptions that develop themselves from the study of impact, carried fearlessly to its legitimate conclusions.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

The Use of Colour Screens with a Low Sun.—In the September number I wrote:—"As the sun gets low the daylight gets markedly more yellow, and we have from time to time been instructed that the excessive blue sensitiveness of gelatino-bromide plates becomes so far negatived on account of this change, that it is not necessary to obviate it by the use of a yellow or orange-coloured screen. Whether or not this is so depends on what the photographer wants. If he seeks to photograph an evening effect as if it were lit by such light as given by the sun only when he is high up in the heavens, while the general effect is such as can be obtained only when he approaches the horizon, then he may omit the coloured screen. But if his aim is to photograph the scene before him as it is, there is

as much need for the yellow screen at sunset as at midday." I learn from the columns of a contemporary that this passage has "sadly troubled" him and at least two of his readers. This I regret, but would suggest that those who wish for further explanations of any matter in these chapters would do well to address our editor, or me through him, as then they will be certain of getting such assistance as I can render. I cannot undertake to read other journals for the sake of finding comments on what I say here.

The point of the above extract is that the excessive blue sensitiveness of the plate is an error of the plate, and if not compensated will produce its effect in a photograph taken when the sun is low as well as when the sun is high. That if the partial loss of blue light as the sun gets low (the light becoming yellowish by reason of this loss) is accepted as compensation in photographing late in the day, and the yellow screen is discarded, then the colours of the objects photographed will be rendered in the photograph as if they were lit by a midday sun and the yellow screen were used. It would be an anachronism to represent an evening scene with a low sun as if the quality of the light were such as we get only with a comparatively high sun but we are so used to errors of this kind in photography that our sense of criticism is dulled. The error is in the plate, and whenever the plate is used the screen should be used if it is desired to represent the scene as it appears when photographed.

Indoors it is possible to use a yellow light instead of a screen, and it will be found that ordinary gas or lamp light will compensate the plate error to about the same extent as a yellow screen that requires the exposure to be increased four or six times. But the photograph taken by gas light will not render colours as they appear by gas light, but as they would appear by a whiter light more similar to daylight. If one has a colour screen that is made to properly compensate the errors of colour sensitiveness of the plate, then the screen should *always* be used when it is desired to render colours with the tone values as they appear at the time of photographing them.

The Royal Photographic Society's Exhibition.—Although the relation between the dates of the opening of this exhibition and the publication of this journal renders it impossible to refer to any of the exhibits until after they have ceased to be on view, there are a few points connected with the scientific and technical section that it may be of interest to refer to. The making of a series of consecutive photographs of changing objects at suitable and stated intervals so as to show the character and progress of the change, is an application of photography that has much to commend it. There were several examples of such work this year as there have been in previous exhibitions, the most notable being a series of seventy photographs by Mr. W. M. Martin, showing the embryology of a chicken. Of this series some were taken by transmitted light, some by a combination of transmitted and reflected light, and one by Rontgen rays; that is, the illumination was varied in order to best show the required detail—a consideration in such work that does not always receive the attention that it might. The application of Rontgen rays to the demonstration of internal and hidden structures was exemplified in a novel way by Dr. Rodman in a number of radiographs of Mollusca. The internal anatomy of each shell was shown with surprising clearness, and the systems of complex and superposed curves often formed figures of great beauty.

A portrait taken with ultra-violet radiations obtained by means of the screen devised by Professor R. W. Wood was shown by Mr. Edgar Senior. It merely demonstrates in a striking way the possibility of photographing an object quite in the dark. The portrait was very passably focussed, considering that the object and the image were both invisible, and that lenses are not corrected for the purpose of using them in this eccentric manner. A telephotograph of the upper part of St. Paul's Cathedral, by Mr. A. E. Smith, was an excellent production from a technical point of view. The magnification was twenty-four diameters, and as one thousand feet of London atmosphere intervened between the object and the camera, it was an excellent illustration of how an almost hopeless task may be successfully accomplished by selecting suitable conditions. Those interested in Mr. J. Hort Player's ingenious method of copying engravings, &c. (Playertype), will be glad to know that Mr. Player showed some very satisfactory enlargements produced from negatives obtained by his process.

Coloured Films.—The necessity for controlling the character of the light that may be available is ever present with the practical photographer. Too often he has to be content with some commercial article made for a quite different purpose that happens to be sufficiently near to what he requires to be serviceable. Bookbinders' cloth, coloured tissue paper, hock bottles, and other such makeshifts, are still commonly used, though in a few cases the demand has been met by more suitable and specially-prepared media. A further step in the right direction has recently been made by Dr. G. Krebs, of Offenbach-on-Main, who has put upon the market a considerable assortment of tough coloured films, specially made for the various purposes for which coloured media are required. They are known as the "Geka flexoid filters." Many, if not all of them, have been prepared from formulae suggested by Dr. Miethe. I have examined several, and can confirm the statement that they do, practically speaking, absorb that part of the spectrum that they are stated to in the description of them, and that they form such series as are most generally needed. There are a yellow and three red films for dark-room lamps, transmitting the red and green, the red alone, the red beyond wave-length 610, and the red beyond about C, respectively; yellow films of three depths for use with orthochromatic plates; blue, green, and red filters for three-colour work, and many others of various kinds. They are obtainable in sheets of all sizes up to 15 by 12, and even larger, from the importers, Messrs. A. E. Staley and Co.

School of Art Wood-Carving.

The School of Art Wood Carving, South Kensington, which now occupies rooms on the top floor of the new building of the Royal School of Art Needlework in Exhibition Road, has been re-opened after the usual summer vacation, and we are requested to state that some of the free studentships maintained by means of funds granted to the school by the London County Council are vacant. The day classes of the school are held from 10 to 1 and 2 to 5 on five days of the week, and from 10 to 1 on Saturdays. The evening class meets on three evenings a week and on Saturday afternoons. Forms of application for the free studentships and any further particulars relating to the school may be obtained from the Manager.

A School on the Ocean.

American educational enterprise is responsible for the scheme of a "Nautical Preparatory School"—in other words, a school on board a ship that is constantly afloat in the various maritime regions of the world. A vessel of this kind, to effect its purpose, must, of course, carry a professorial staff, whose members are qualified to conduct the education of pupils, as well as look after their moral and material welfare. But the studies of sea-going scholars of this type, while akin to those which form the curriculum pursued within the four walls of a high-grade establishment on shore, are supplemented by the novel opportunities and ever-changing environment of a cruising vessel.

The *Young America*, the craft on which this bold experiment in educational methods is to be carried out, is a newly-built full-rigged sailing ship, the keel of which was laid at Newport, Rhode Island, in the summer of 1902. She has a displacement of about 3,000 tons, and length of 202 feet, and is claimed to be of the most modern type of marine architecture. Electrically lighted throughout, the vessel is provided with all the requisites of up-to-date sanitary and hygienic science, and also those which meet the peculiar needs of a wayfaring ocean school. Two steam launches are borne, and ten rowing and sailing boats of navy pattern.

The *Young America* sailed from Newport on her first voyage in September last, and it is of interest to note that the maiden cruise of the ship is to this country, Edinburgh having been selected as the first city or port of call, and London as the second.

Our visitor carries upwards of 250 American lads, denominated "cadet pupils," and, as at present arranged, a complete student course for these occupies four years, during each of which an itinerary of cruises is performed to various parts of the world. It is not, however, obligatory to enrol for the whole period. In the first year, 16,000 miles will be traversed. From Edinburgh and London the ship proceeds to Christiania, Copenhagen, Gibraltar, the Mediterranean, the ports of the West Indies, and thence home to the United States, when a vacation of four months ensues. During the second year, Lisbon, Venice, Constantinople, and Santiago comprise a few of the ports of call of the cruise. The third year the ship visits St Helena, Cape Town, Bombay, Calcutta, Hong Kong, Yokohama, and San Francisco. In the fourth and last year, Hawaii, Sydney, Hobart Town, Valparaiso, Rio de Janeiro, St. Thomas, and Charleston are among the ports of call. Vacations follow each ended cruise.

At first sight it would seem that here a training-ship is the central idea of the plan. But the school on the *Young America*, it is requisite to state, is not primarily designed to train boys for sea service, though, doubtless, in the nature of things its associations and influence will in many cases assist what may be the embryo stages of naval careers of the future. Strictly speaking, it is a school on a ship, and not, in the more limited sense, a school-ship. The cadets take no part in the working of the vessel, except for purposes that accompany the routine of discipline, drill, gymnastic exercise, and the ability to hand, reef, and steer. From the last-named operations there is no escape.

Notwithstanding that the actual work of the ship is carried on independently of the cadets, the organisation is planned on naval lines. The *Young America* is commanded by an experienced officer detailed under the provisions of the United States Navigation Laws, and the disciplinary standpoint is similar to that of the world-renowned United States Naval Academy. The cadets are formed into companies, and the companies into sections, the respective ranks in the latter being: cadet officers, cadet lieutenants, midshipmen, and probationers. Boys in the highest grade act as officers of the watch, performing duties identical with those of the ship's officers of like rank, only, however (so it is said), for purposes of physical development, amusement, or as a reward of merit, the duties themselves being carried on outside school hours.

A service as well as a dress uniform is worn, while other articles of clothing conform to the standard patterns. Such, in brief, is the naval aspect of the ship's management; the rest is an affair of the teaching faculty.

A body of 25 professors conduct what are called collegiate and commercial courses. The former comprises an educational training for cadets who subsequently intend entering American colleges, the U.S. Naval or the U.S. Military Academy, or to secure a liberal education independently of attendance at any higher institution. The plan of the latter course is laid on broad lines, the object of which is to impart a sound general education, coupled with a practical knowledge of the world's commerce, derived as much as possible from personal observation in widely differing countries. In both sections the teaching of modern languages is a feature; those that may be taken up are: French, German, Spanish, and Italian. Certain of the cadets are instructed in theoretical navigation, and steam and electrical engineering. Considerable attention is to be given to various branches of science—indeed, in some respects, the *Young America* modestly subserves the functions of a scientific and exploring expedition. Under the fostering eye of a competent Director of Science, Prof. Porter E. Sargent, deep-sea dredging will, with suitable equipment, be pursued, and the treasures and wonders of the tow-net set forth and explained. Then it is hoped that the visits on shore during the ship's "globe-trotting" will afford ample facilities for judicious scientific collecting.

It is not to be expected that the gates of the world will fly open to these cadet pupils; and we may hope that they will not broaden into sea prigs. Still, it cannot be doubted that the world-wide travel that is forecasted, in alliance with scholastic training, will be of high advantage if properly assimilated and adjusted to the needs of after-life requirements. It is a grand tour of the seas, and round-the-world itinerary of cities and sights of peculiar significance. A broad hint has been given that America's foreign trade should ultimately receive stimulus, and new outlets crop up for the development of her industrial and scientific manufactures by the educational method in question. If that be so, surely no one will grumble at the means adopted to supply the fair promise.

The management of the *Young America* is vested in a company, of which Lieut.-Commander C. H. Harlow, an officer in the United States Navy, is president, and associated with him are several prominent naval and industrial authorities.

It should be added that pupils are enrolled on the roster of the school between the ages of 14 and 19 years inclusive. *Bon voyage.*

Sunspot Variation in Latitude.

By William J. S. Lockyer, M.A., Ph.D.

From a study of the facts regarding the distribution in latitude of spots on the surface of the sun, Mr. Maunder and I evidently hold different opinions, and I do not think that a further discussion of the subject will tend either to change them or advance our knowledge of this spot distribution.

Perhaps I may, however, be permitted to make a final reply to some of Mr. Maunder's remarks in your October issue.

Speaking of the term "spot-activity track," Mr. Maunder says: "It is abundantly clear that he did intend to intimate by it that the spots were gathered together in certain districts or regions, *separated from each other by broad, barren intervals*, and that these districts, rich in spots, moved continuously downwards towards the equator." (The italics are mine.)

I am afraid Mr. Maunder cannot have read my paper thoroughly, or even carefully looked at the figure on page 144.

In the paper I have stated (p. 145), "in this way it was possible to trace the varying positions, as regards changes of latitude, of the *centres of action* or *maxima points of the curves*, from year to year . . ."

And on page 147 the term "spot-activity tracks" is applied "simply to the changes of positions of the regions in which they (the spots) are *most numerous*."

I have nowhere mentioned that these regions were separated from each other by "broad, barren intervals," as he calls them, for such a statement would be against all the facts; if the text and diagrams be consulted, no such general deduction can possibly be made with accuracy.

It was to make this, among other points, clear, that Fig. 1, p. 181, in the August number of this journal was inserted, where it will be seen that the portions of the curves between the individual maxima do not reach down to the zero line, which they should do if those regions were "broad, barren intervals." If Mr. Maunder considers that these "broad, barren intervals" are suggested on the curves marked A in plates 4 and 5 of my paper, then this is another indication that he has not read it carefully before criticising it. In describing these curves to which reference has just been made, I pointed out (p. 146) that they "were proportionally thickened to indicate approximately the relative amount of spotted area *at these centres of action*, or, in other words, the heights of the maxima points on the yearly curves. These curves thus indicate for each year the positions, as regards latitude, of the particular zones in which *the centres of spot-activity* occur."

Mr. Maunder in his letter states further that he "explained therein the nature of the mistake which Dr. Lockyer had made with regard to the maxima on which he based his paper, and that his method of joining them up so as to show apparent lines of drift was not only purely arbitrary, but was often against very distinct and positive evidence."

I am afraid, however, I cannot accept this explanation which he has so gratuitously offered. To my mind the larger the sunspot or its greater extent in latitude, and the longer it exists, the more important becomes the region in which such a disturbance takes place. Mr. Maunder evidently thinks otherwise.

In the note on page 150 of this journal, which from its general tone I assume Mr. Maunder wrote, it is stated that "Mr. Maunder showed that the Greenwich Sunspot Results for the last 30 years fully confirmed Spörer's Law," yet Mr. Maunder now claims priority for a statement I have made which is not in strict accord with this law.

According to Spörer's Law, formulated about 1880, the highest spot latitudes occur about the time of sunspot minimum. In my paper I suggested that this law needed modification because an analysis of the facts indicated that:—

(*a*). Outbursts of spots in high latitudes are not restricted simply to the epochs at or about a sunspot minimum, but occur even up to the time of sunspot *maximum*.

(*b*). The spots tended to reach their highest latitudes at or about sunspot *maximum*.

(*c*). From sunspot maximum until about the following minimum high latitude spots were for the most part conspicuous by their absence.

The above three deductions, all of which can be gathered from an intelligent examination of the plates accompanying my paper, show that the appearance of spots in high latitudes bears a fairly definite relation to the sunspot maxima and minima epochs.

Mr. Maunder refers to a paper (*Monthly Not.* May, 1903) prepared by him by the desire of the Astronomer Royal, in which his deduction as regards the occurrence of high latitude spots is as follows:—

"Taking them as a class by themselves, they were seen irregularly, appearing at times which did not seem to bear any fixed relation to any one of the four chief stages of the sunspot cycle—minimum, increase, maximum, and decline. . . ."

Since Mr. Maunder's "brief preliminary text," to which he refers, suggests an *irregularity* of appearance of high latitude spots, and my statement restricts this time of appearance from about a sunspot minimum to about a sunspot maximum at which the highest latitudes are attained, I fail to see how he can "claim" the priority of the deduction I made.

Mr. Maunder has further forgotten to mention one of the conclusions, corroborating my statement, to which Father Cortie recently arrived, namely:—

"Greater disturbances are most prevalent in high latitudes at or near the times of solar maximum . . ." (*Monthly Not.*, Vol. 64, p. 766.)

Would not Father Cortie also have referred to Mr. Maunder's "brief preliminary text" if a statement equivalent to the above had been previously published by Mr. Maunder?

In conclusion I may be permitted to add that it was very far from my thoughts to take the "results" of Mr. Maunder's paper as he states in his last letter. Researches at the Solar Physics Observatory rendered it necessary to make a detailed study of sunspot observations, and use was made, by permission of the Astronomer Royal, of *data* (which at the request of the Solar Physics Observatory had been brought up to date) and not of *results* derived by Mr. Maunder.

It seems necessary to point out to Mr. Maunder that observations are made, collected, and reduced at public expense, in order that they may be studied by those who wish to utilise them for the purposes of science, and are not the "property" of any computer or assistant who may have been charged with the duty of preparing them for publication.

NOTES.

ASTRONOMICAL.

The Nebulae and the Milky Way.

It is often stated that the nebulæ properly so called—the "white" nebulæ—avoid the galactic region and cluster towards its two poles. It is manifestly so with respect to the north pole of the Galaxy, but Dr. C. Easton, in the *Astronomische Nachrichten* (No. 3960), questions if the same relation holds good for the southern pole. The statistics at our disposal do not bear it out, but this has hitherto been generally explained as due to the insufficiency of observations in the southern hemisphere. Dr. Easton shows that this is not the case: for since the Galaxy is inclined at an angle of 60° to the equator a considerable part of the galactic northern hemisphere lies to the south of the equator, and of its southern hemisphere to the north. Calling the former segment A, the latter B, we have

Faint nebulæ	A	754	B	1043
Bright nebulæ	A	152	B	71

If nebulæ were really distributed on the whole in the same way in the two galactic hemispheres, and if any apparent want of the expected condensation round the south galactic pole were simply due to the insufficiency of observations in the southern hemisphere, then more nebulæ, both bright and faint, should be observed in segment B than in segment A. There is an increase in faint nebulæ, but a most striking falling off in bright. This indicates a great increase in the proportion of faint to bright nebulæ in the galactic southern hemisphere, and it is exceedingly improbable that future observations in the southern hemisphere will discover so large a number of nebulæ round the south galactic pole as to bring it into symmetry with the northern. The distribution in the two hemispheres appears to be different, and Cleveland Abbe's theory of an "ellipsoid of nebulæ," with its major axis at right angles to the galactic plane, seems to accord with this want of symmetry. Dr. Easton, in the concluding portions of his paper, regards the faint nebulosities as allied to the stellar agglomerations of the Milky Way; the nebulæ properly so-called to the sparsely distributed stars of the general stellar system, the non-galactic stars.

* * *

Explanation of the Martian and Lunar Canals.

Professor W. H. Pickering, in *Popular Astronomy*, declines to follow Mr. P. Lowell in his heroic scheme of artificial pumping to account for the flow of water in the Martian canals. He shows that the lunar canals are dotted by small craterlets, and are so symmetrically connected with them as to show a causal connection. He therefore suggests that the canals on the Moon, and by analogy on Mars also, are lines of volcanic action where the crust has been fractured, and that enough water and carbonic acid may escape from the centre craterlet and flow down its sides to develop the vegetation upon its slopes, whilst the smaller quantities escaping from various points along the radiating cracks similarly develop the vegetation along their course, the "lakes" and "canals" as we see them being thus regions of vegetation. On account of the rarity of the atmosphere, the vapours, instead of rising, would immediately spread themselves along the surface of the ground.

The *Monthly Review* for October contains an article on "The Markings on Mars: a Plea for Moderate Views," by Major P. B. Molesworth, R.E. Few astronomers can speak on the subject of Mars with the authority of Major Molesworth, since his studies of the planet have been carried on under exceptionally good observing conditions, with the utmost perseverance, and with great skill in delineation. He concludes that: (1) The markings on the surface of the planet are more or less permanent, but subject to minor changes. (2) Their intensity depends in some way on the Martian seasons. (3) The structure of the delicate detail is the same all over the planet, both in the light and dark areas, the only difference being in the varying tone of the "background." (4) This detail is "the integration of markings far too small to be separately defined."

* * *

The Ninth Satellite of Saturn.

The first visual observation of this object was obtained on August 8 by Professor E. E. Barnard at 18 hrs. 0 min. G.M.T. Its apparent place was R.A. 21 hrs. 23 min. 1·0 secs.; declination. 16° 30′ 8″. On September 3 Professor Barnard found no star was visible in this place. The magnitude of the object was estimated at 15·5 or 16·0. Another observation by Professor Barnard is dated September 12, when the magnitude of the satellite was given as 16·7.

In the number of the *Observatory* for October, Mr. Crommelin gives the result of a rough preliminary examination of the orbit from the very few observations which have yet been published. He finds that the hypothesis of retrograde motion suits the observations as given much better than that of direct motion. This, if established, would be a most extraordinary circumstance, the other eight satellites moving directly. Mr. Crommelin gives the siderial period as 443 days, and the distance 6,900,000 miles, inclination to ecliptic about 6°, to Saturn's orbit about $4\frac{1}{2}$°, to Saturn's equator, 30°. The magnitude given by Professor Barnard, 16·7, would correspond to a diameter of about 120 miles.

* * *

Radiation in the Solar System.

In the course of an address given to the British Association, Professor J. H. Poynting gave in clear and succinct form some of the conclusions which may be drawn from researches in recent years, both on the temperature effects of radiation and the effects due to light pressure. Beginning with Stefan's law, that the stream of energy is proportional to the fourth power of the temperature, reckoned from the absolute zero 273° below freezing point on the Centigrade scale, he quoted, as probably not far from the true value, that the stream of radiation from the sun falling perpendicularly on 1 sq. cm. *outside* the earth's atmosphere would heat 1 gramme of water $\frac{1}{24}$° C. every second, or would give $\frac{1}{24}$ calorie per second. Hence he deduced that the mean temperature of the sun's radiating surface is 6000°, if the sun radiates as a body would do which is perfectly black when cool. Further, he gave a table of temperatures at various planetary distances from the sun's centre:—

Distance from the Sun's centre.	Temperature Centigrade.	
At Mercury's distance....	210°	Tin nearly melts.
At Venus's distance......	85°	Alcohol boils.
At Earth's distance......	27°	Warm summer day.
At Mars distance........	−30	Arctic cold.
At Neptune's distance ..	−219°	Nitrogen frozen.

Now, the estimated mean temperature of the earth's surface is about 16° C., which is sufficiently near the value given in the table when the radiation from the surface of the atmosphere and other such conditions are taken into account. Professor Poynting then points the moral that, given atmospheric conditions on Mars not very unlike those on the earth (as observation seems to show), even the highest equatorial Martian temperature cannot be much greater than −38°, and "it is hard to believe that he can have polar caps of frozen water melting to liquid in his summer and filling rivers or canals. Unless he is very different from the earth, his whole surface is below the freezing point."

Turning, then, to the effects of light pressure, he gives the total effect on the earth at its present distance from sunlight as 70,000 tons. Since gravitation depends only on the mass and light pressure on the surface area, it follows that were the earth's volume divided up into separate spheres, each $\frac{1}{40000}$ cm. in diameter, the pressure of light would balance the pull of gravitation. If, on the other hand, we diminish the radiating body whilst retaining its high temperature, we find similar effects. If it were possible to reduce the sun to a dia-

meter of 20 miles, whilst keeping its temperature of 6000° C., a balance between the pull of gravitation and the push of sunlight would again be held even. If, in addition, we diminish the temperature, Professor Poynting showed that two spheres, each of the density and temperature of the earth, would neither attract nor repel each other when their diameters were about 0·8 cm., if they received no appreciable radiation from the surrounding region. This last result is of importance in relation to the meteoritic theory. Seven centimetres is a large value for the average size of meteorites in a swarm, yet Professor Poynting's research seems to indicate that the tendency of the members of a swarm smaller than these would be to repel each other and scatter, not to attract each other, collide and ignite.

BOTANICAL.

By S. A. Skan.

Professor A. Nestler, whose investigations into the poisonous properties of *Primula obconica* were the subject of a note in "Knowledge" about three years ago, has now published, in the form of a brochure of 40 pages and four plates, a more comprehensive account of his experiments with various species of the genus, undertaken to ascertain which of them are capable of producing skin-irritation, and the origin, properties, and effects of the poison. Injury is caused most commonly by *Primula obconica*, to which species the paper is chiefly devoted; but Professor Nestler has clearly proved that other species are also poisonous, though less virulent. The well known Chinese primrose (*P. sinensis*), *P. Sieboldii*, and *P. cortusoides*, all three of which belong to Pax's section Sinenses, in common with *P. obconica*, have been tested and proved poisonous. Eleven other species, including *P. officinalis*, *P. farinosa*, and the Auricula (*P. Auricula*), were also tested, and were found to be innocuous. The author shows that the irritation of the skin is caused by the yellowish secretion of the glandular hairs which clothe the underside of the leaves and the flower-stalks. This secretion contains large numbers of variously-shaped, often needle-like, crystals, and its effects on the skin appear to be identical with those of menthol.

* * *

The Welsh poppy (*Meconopsis cambrica*), which is found wild in Wales and some of the western counties of England, is probably the only species of the genus known to many of the readers of "Knowledge." There are, however, several others, some of which, such as *M. nepalensis*, *M. Wallichii*, and *M. heterophylla*, may be met with in English gardens. Altogether about 20 species are known, and they mostly inhabit the high-level regions of Northern India, Western China, and Tibet. The interesting circumstances attending the introduction of another species to cultivation are recorded in a recent number of the "Gardeners' Chronicle." This species, *M. integrifolia*, has for a long time been represented in herbaria, and attracted the attention of Messrs. Veitch, of Chelsea, who dispatched a collector to the Eastern Tibetan frontier with the main object of procuring some seeds. The plant was found growing in great profusion at elevations from 11,000 to 15,500 feet, and was only reached after an arduous journey, during which the travellers suffered more or less from the rarefied atmosphere, from the cold, and from snow-blindness. Its seeds were secured and sent to England, and now its large yellow flowers, which in the wild specimens are sometimes 8 to 10 inches in diameter, have for the first time appeared in our gardens.

* * *

A Bath firm of engineers has recently met with some vegetable matter in the water of the famous King's Bath, of which the temperature is about 120° F. It was found in a shaft through which the water from the hot spring rises and overflows to fill the bath, and proves to be a filamentous Alga known as *Oscillaria thermalis*. Mr. G. S. West has an interesting paper in the "Journal of Botany," 1902, in which he gives an enumeration of species of Algæ found in a collection made in the hot springs of Iceland, with the addition of a few from the Malay Peninsula. In Iceland the highest temperature of the water in which plants were collected was 185° F. The late Professor W. H. Brewer, in a note published in the "American Journal of Science," 1866, XLI., records the presence of living Algæ in the geysers of Pluton Creek, California. In this case the highest temperature of the water found to contain living plants was about 200° F.

ORNITHOLOGICAL.

By W. P. Pycraft.

Red-backed Shrike Breeding in Confinement.

Dr. A. L. Gunther, F.R.S., is to be congratulated on having succeeded in breeding the Red-backed Shrike, *Lanius collurio*, in confinement. In the *Avicultural Magazine* for October he gives a long and delightful description of the habits of his birds both before and during this momentous time.

Taken from the nest last year, and reared by hand, they were turned out early this year into a large aviary, affording plenty of cover in the shape of large bushes. Towards the end of May, Dr. Gunther first made the discovery that nesting operations were going on by finding a nest in a holly bush 4 feet from the ground, and containing five eggs. This nest, be it noted, though built by birds which had never known freedom, was in all respects typical of the species.

On June 6, after 14 days' incubation, five young appeared—nearly a month earlier than would be the case with wild birds. Unfortunately, cold weather soon set in, and this proved fatal to the callow young, which died on June 14.

The bereaved birds, however, soon began to pair again. By June 24 the female was sitting on the old nest; on another clutch of five eggs, which, curiously enough, were more brilliantly coloured than those of the first clutch. On July 7 four of the eggs had hatched out, the fifth next day. This last nestling was conspicuously smaller than the rest, and died next day; another death occurred on the 11th. By the 23rd two of the three remaining young had left the nest; the third followed next day. But they had evidently started too soon, as the flight feathers were not big enough, and they had to spend the next three days on the ground before they could get back into the bush again.

By August 28 the parents had ceased to feed them, and they are still flourishing.

* * *

Birds of Paradise in England.

No less than five Birds of Paradise are now living in the aviaries of Mrs. Johnstone, a prominent member of the Avicultural Society. Three species are represented—two King-birds of Paradise, *Cicinnurus regius*, to be transferred immediately, we are happy to say, to the Gardens of the Zoological Society, two Lesser birds of Birds of Paradise, *Paradisea minor*, and one Great Bird of Paradise, *Paradisea apoda*, and all are in excellent condition.

Never before, probably, has *Cicinnurus regius* been seen alive in Europe. It is therefore to be hoped that they will live long, more especially as they are regarded by many as the most beautiful species of their kind.

* * *

Immigration of Great Snipe.

During the end of September these islands appear to have been visited by considerable numbers of the Great or Solitary Snipe (*Gallinago major*), inasmuch as individual specimens are recorded as having been shot in Shetland on September 20, in Caithness and Dumfriesshire on September 28, and in Coventry on October 1.

Though occurring regularly every year in England, it is regarded as a rare autumnal visitant both in Scotland and Ireland.

The Great Snipe is peculiar in haunting much drier places than the Common Snipe.

Osprey in Surrey.

During the middle of September one of these magnificent birds took up a temporary residence near the lake at Cranleigh, and, as might have been expected, was shot almost immediately—charged with depredations on rainbow trout which have been introduced there. Since then another of these birds has been seen, and an appeal has been made by Mr. John Bickerdyke, in the columns of the *Field* for October 1, for its protection.

* * *

Aquatic Warbler in Norfolk.

The *Field* (October 8) records the capture on September 15 at Cley, in Norfolk, of an aquatic warbler, *Acrocephalus aquaticus*. This is the seventh occurrence of this bird in Great Britain. The sex of this last specimen is not stated.

* * *

White Waterhen.

The Natural History Museum at South Kensington has just received a very beautiful variation of the Common Waterhen. The bird, which was killed at Stour, Dorset, on October 2, is very nearly entirely white, the red colour of the frontal shield, and the green colour of the legs, forming a very handsome contrast with the snowy plumage. The red colour of the beak and the "garter" round the leg, it is interesting to notice, was very intense, but the green pigmentation of the legs and toes was paler than normal; the claws, indeed, were nearly white.

ZOOLOGICAL.

By R. Lydekker.

The Mammals of Central Asia.

In connection with the article in our September number, on the mammals of Tibet, considerable interest attaches to Dr. W. Leche's account of the large mammals collected by Sven Hedin during his travels in Central Asia between 1899 and 1902, published at Stockholm, in the sixth volume of the "Scientific Results" of that adventurous journey. Perhaps the most interesting conclusion is that the wild camels found in large droves in the deserts of Central Asia are truly wild animals, and not, as has been generally supposed, the descendants of individuals escaped from captivity. From the existence of intermediate forms, the author is led to confirm the view of the present writer that the Tibetan argali is merely a local race of the Siberian animal, and that it should consequently be known as *Ovis ammon hodgsoni*. He also describes a stag which appears to be in some respects intermediate between the Yarkand (*Cervus canadensis*) and the Lhasa stag (*C. albirostris*); and arrives at the conclusion that the two forms of bear mentioned in our article belong to a single species (*Ursus pruinosus*).

* * *

Armoured Cat-Fishes.

An important memoir, by Mr. C. T. Regan, of the British Museum, on a peculiar group of South American freshwater fishes, which may be popularly known as armoured cat-fishes, has recently been published in the *Transactions* of the Zoological Society. For a long time these fishes were included among the *Siluridæ*, or true cat-fishes, as typified by the wels (*Silurus glanis*) of the rivers of Continental Europe, but are now regarded as forming a family (*Loricariidæ*) by themselves. The majority of the characters by which these fishes can be distinguished from the *Siluridæ* are connected with the skull and skeleton, but the more typical forms may be easily recognised by the armour of overlapping bony plates protecting the body, from which the type genus *Loricaria* takes its name; the inferiorly-placed sucking mouth is also very characteristic. There are, however, certain degenerate types, such as *Arges*, in which the armour has been completely lost. Probably these fishes are derived from the *Siluridæ*, and their recognition of their right to rank as a family adds one more peculiar type to the fauna of Central and South America, which their ancestors may have reached by means of a former land-connection with Africa, and where they range from Panama and Trinidad or Porto Rico to Uruguay. No less than 189 species, arranged in 17 genuine groups, are recognised. It appears that these fishes are in the habit of anchoring themselves to stones in the river-bed by means of the sucker-like mouth; respiration being at such times effected by taking in water through the gill-openings and expelling it again by the same aperture in the opposite direction. Most of the genera are represented in all the South American river-systems, while even some of the species have a very wide geographical distribution.

* * *

"The Paca-rana."

In this column reference has previously been made to Dr. Goeldi's interesting re-discovery of the remarkable Peruvian rodent *Dinomys branichi*, hitherto known only by a single individual captured in 1873. As Dr. Goeldi's paper is now published in the October issue of the Zoological Society's *Proceedings*, a few notes may be added on such an interesting creature. In the first place, it appears that the animal is known to the Tupi Indians, by whom it is called the páca-rána, or false páca, in allusion to the resemblance of its coloration to that of the true páca (*Cœlogenys paca*), from which it differs, however, by its well-developed tail and the absence of cheek-pouches. The Tupi name may be adopted as the popular title of the species. Dr. Goeldi states that the páca-rána is a rodent of phlegmatic and gentle disposition, which may account perhaps for its rarity, if, indeed, it be really scarce in its native home, which is probably the eastern slopes and table-lands of the Bolivian and Peruvian foot-hills bordering on Brazil, inclusive of the headwaters of the Purus, Acre, and Jurua rivers. Dr. Goeldi adds that he "shall soon have occasion to show that a scientific exploration of that region will result in a multitude of great surprises both from a zoological and a palæontological point of view, of which the interesting re-discovery of *Dinomys branichi* is only a first instalment."

* * *

The Races of Europe.

In his Huxley Memorial Lecture, delivered on October 7, Dr. Deniker, after referring to Huxley's recognition of two main stocks, the fair Caucasians, or Xanthochroi, and the dark Caucasians, or Melanochroi, in Europe and Asia, expressed the opinion that there are really six well-marked European races of mankind. These are (1) the blonde, wavy-haired, long-headed, long-faced, and tall Northern Race; (2) the Eastern Race, which is also blonde, but has straight hair, a rather short head, and broad face, with a short stature; (3) the Ibero-insular Race, of Spain and Portugal, which is dark, very short, long-headed, with straight or retroussé nose, and sometimes curly hair; (4) the Western Race, dark, round-headed, and short, with round face, broad nose, and thick-set body; (5) the Atlanto-Mediterranean Coast Race, very dark, moderately long-headed, and fairly tall; and (6) the Adriatic Race, from the borders of the Gulf of Venice, which is dark and short-headed, with the nose slender and straight or arched.

* * *

The New Central African Pig.

When Stanley heard of the occurrence in the forest of Central Africa of the animal now known as the okapi, he also saw or received reports of a large species of pig. These reports have proved true, for Mr. R. Meinertzhagen has killed specimens of a wild swine from the eastern side of the great forest, the spoils of which have safely reached the Natural History Museum. Mr. O. Thomas reports that these indicate not only a new species, but likewise a new generic type of wild swine, for which he suggests the name *Hylochœrus meinertzhageni*. The forest hog, as it may be called, apparently comes nearest to the wart-hogs (*Phacochœrus*) of Africa, but has a less specialised type of skull and dentition, and thus serves to connect those hideous creatures with more typical swine. The tusks, although very much smaller, have the characteristic curvature of those of the wart-hog, and there is the same reduction in the number of the upper incisors to a single pair. The coat of black hair is, however, much more profuse than in the wart-hogs. Although the discovery of this new type falls far short of that of the okapi in the matter of interest, yet it is nevertheless one of very considerable zoological importance. Unfortunately, the specimens sent home are too imperfect for mounting. Mr. Thomas's description of the new animal appeared in *Nature* of October 13.

An Electric Influence Experiment.

Interesting Illustration of the Principle of the Wimshurst Machine.

By Charles E. Benham.

The following simple experiments will be found entertaining in themselves, and at the same time they will help to elucidate the principle of the remarkable accumulation of electricity which occurs in the well-known Wimshurst influence machine.

Take four pieces of glass—half plate negative glass ($6\frac{1}{2}$ by $4\frac{3}{4}$) will do very well—and mount a 3-inch circle of tinfoil on each, a little above the centre, as shown in fig. 1. Coat the glass well on both sides with shellac varnish, which, by the way, should always be filtered through a few thicknesses of fine muslin to ensure a good smooth surface.

Fix two of the glass plates, which we will call A and B, edge to edge horizontally, with the tinfoil downwards, holding them in a vice, or pushing their ends into a grooved block of wood as shown in fig. 2.

Lay the two other plates, C and D, with tinfoil upwards, on the fixed plates, C on A and D on B. The tinfoil not being central, the glass will project beyond the edge of A and B, thus enabling C and D to be handled and moved as required in the experiment.

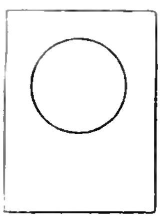


Fig. 1.

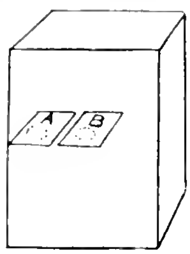


Fig. 2.

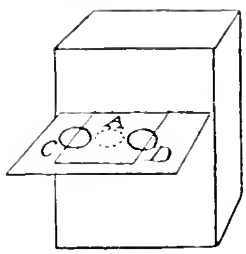


Fig 3.

Touch C and D with the finger and they will receive from A and B respectively an infinitesimal charge of electricity, probably quite imperceptible, even with a delicate electroscope. Remove the finger, and then without displacing C turn D over on to it, so that the two tinfoils of the upper plates are in contact. The surface of C D will now have the combined charges of C and D. Touch A, and it will receive by induction a charge equivalent to this combined charge—still an imperceptible one. Lay the pair on B and touch B, which will likewise receive a similar double charge. Open out the two plates and repeat the whole process. It will be seen on consideration that the second time C and D will receive practically double the charge they first took up. At the third operation they will again double their last charge, and so on. It is not really quite double, but taking the accumulation as being practically in that ratio, it means that in ten operations the original charge will have increased more than a thousand times. At any rate, before the tenth time sparks will probably be observed at each touching of the tinfoils, and will be found to increase every time until the limit of the capacity of the surfaces is reached.

To those who are familiar with the principle of the "doubler," invented by Bennet more than a hundred years ago, there is nothing surprising about this method of producing electricity, but to the tyro, or to persons unacquainted with electric phenomena, this creation of a powerful and increasing series of sparks without any manifest original source cannot fail to seem astonishing.

It is evident that while electricity is produced by this simple process—and with large plates is produced in considerable quantities—it would be mechanically inconvenient to construct an apparatus to go through these intricacies of touching and transposing glass plates, but a further experiment will show how the most troublesome part of the process may be dispensed with, and will at the same time illustrate in a striking manner the very principle of the accumulative power of the Wimshurst machine.

For this second experiment only three of the tinfoil discs are required (A, C, and D) and it will be more convenient if C and D are on one plate. A being fixed as before, lay the larger plate upon it with the tinfoil C (uppermost) over A. Charge C by touching as before. Then slide the upper plate so that D is over A, and, by touching, charge that too. C and D now have between them double the charge of A, but of course a charge of opposite sign. C and D cannot be brought into contact as before, but if the plate is moved so that A is midway between them (as in fig. 3), A will be under the influence of both, and will, when touched, receive a charge by induction, and a repetition of the process will quickly result in accumulation, so that all three discs will soon be strongly charged. On separating them and touching each in turn, strong sparks will be given off by each.

The application of this principle in the Wimshurst machine is at once obvious, though it has never perhaps been illustrated in this way before. Each sector of the Wimshurst, as it passes under the brush, is earthed while under the influence of more than one sector of the other disc, for it is within the field of at least two or three of them. The sector, when earthed by the brush, is, in fact, in the position of A in fig. 3, while the adjacent sectors of the other disc are equivalent to C and D in the above experiment. Each of the four brushes of the neutralising rods places a sector at a similar advantage for increasing its charge, and hence the ready accumulation of the Wimshurst machine.

After this it also becomes evident why a certain number of sectors are advisable for the Wimshurst machine. It will, indeed, act without any sectors at all, but only while the brushes are new and very large, their ends that touch the glass taking the place of the tinfoil. But in practice, the inventor of the Wimshurst machine recommended that there should never be less than a certain number of sectors, the minimum depending on the size of the plate. The reason for this minimum would appear to be, in the light of the experiments described above, that with widely separated sectors the carriers would not be within the field of more than one at a time, in which case the multiplication of the charge would not take place. On the other hand, sectors can be too numerous. This is not only because of the leakage involved, but also because the carrier (represented by A in our experiment) would then be under the inductive influence, not only of the sectors of the other disc, but also of those to right and left of it on its own disc, which sectors are charged with electricity of sign similar to its own, and tend therefore to neutralise the inductive effect of those on the other disc, which are of opposite sign.

Gluttonous Animals.

By R. Lydekker.

Many kinds of carnivorous animals, such as the larger members of the cat tribe, are in the habit of periodically eating very heavy meals, and then abstaining altogether from food for several days, until the pangs of hunger once more reassert themselves. Pythons and certain other snakes come under the same category, as does also the common or medicinal leech. Such animals clearly are not to be classed as gluttonous—they might almost as well be included among fasting animals—they merely take in large supplies of food at long intervals, and, on the average, do not appear to devour more than a normal amount of nutriment. Vultures, on the other hand, although they likewise require a period of abstention from food of some length after each gorge, do appear to consume very much more than an average quantity of food, and, therefore, strictly speaking, come within the scope of the present article.

The animals to which more particular reference is intended are, however, such as are in the constant habit of consuming abnormally large supplies of food without taking intervals of unusual length between their meals. Among wild animals such instances are rare, but are more common among carnivorous than among herbivorous or frugivorous types. Indeed, among purely herbivorous animals, there does not seem to be a single species, either wild or tame, which deserves to be called a glutton. It is true that sheep and cattle, when suddenly turned into a field of green wheat or other succulent herbage, will often eat such a quantity as to be in danger of suffocation unless operated upon with the trocar; but in this case the evil results are largely due to the nature of the fodder, which, during the process of digestion, develops a quantity of highly expansile gases, rather than to absolute gluttony on the part of the animals themselves. Not but what domestication has a tendency towards the development of greedy and gluttonous habits, as witness the familiar cases of the pig and the duck, the wild ancestors of which are among the most active animals, and display no tendency to over-eat themselves.

Be the exact position in the present category of the above-mentioned wild creatures what it may, there can be no doubt that, as indicated by the first of its popular names, the glutton, or wolverine (*Gulo luscus*) is entitled to a very prominent position among greedy animals. Not but what, as is almost universally the case in analogous instances, the creature's propensities in this direction were considerably exaggerated by the older writers. We may dismiss, for instance, as pure fable the old story that when one of these creatures had indulged in an extra big gorge it was in the habit of squeezing itself between the stems of two fir trees growing close together in order to get rid of its meal. Nevertheless, modern testimony is to the effect that the glutton thoroughly deserves its name, and that its eating powers are well-nigh, if not altogether, unequalled by its compeers in size. It is, however, very difficult to find anything like accurate data on this point, or, indeed, a statement as to the weight of the creature. Here occasion may be taken to refer to the deficiencies of natural history works in regard to the weight of animals. For instance, in three well-known manuals of British mammals no mention is made of the weight of the badger, which might serve as a basis for an estimate of that of the glutton. Roughly speaking, the latter weight may, however, be estimated at between 35 and 45 pounds. Now as regards the amount of meat a glutton has been known to eat, the only definite statement within the writer's knowledge is to the effect that one of these animals consumed 13 pounds at a "sitting," or, at all events, in a single day. And since in a wild state the creature's appetite would probably be sharper, it can scarcely be an exaggeration to say that a glutton can eat about a third of its own weight in a day. It is true that this is nothing like the proportion of food to weight that has been recorded in certain smaller creatures to be noticed later on, but then small animals have very frequently much greater functional activity than larger ones, as witness the muscular power of an ant or a grasshopper compared to that of man. Nevertheless, 13 pounds of solid meat is a good record for a creature of the size of a glutton, which is about half as big again as a badger.

Not only is its appetite wonderfully good, but the glutton displays extraordinary acuteness and perseverance in getting at stores of concealed food; somewhat tainted carcases forming its favourite *bonne-bouche*. In the forest districts of Arctic North America, which, in common with similar latitudes in the old world, form the home of the glutton, the hunters are in the habit of concealing the carcases of their quarry in *caches* for future use; and from such depositaries it is almost impossible to keep out the wolverine, which has been known to gnaw through a solid log of timber in order to obtain access to the dainty. When access is gained, the creature will gorge itself to satiety, and, what is more, will shortly after return for another and yet another meal, until the supply is finished; for the glutton, unlike the larger cats, does not apparently stand in need of a protracted fast after a carouse, but has scarcely finished one meal when it is ready for another.

Most of my readers, it may be presumed, are acquainted with the wolverine at least by its fur, which is now largely used for carriage-rugs, samples of which may be seen in the furriers' shops, where a stuffed specimen of the entire animal is also sometimes exhibited. Indeed, the specimen now exhibited in the Natural History Museum was bought ready stuffed from Messrs. Shoolbred. Somewhat badger-like in general appearance, but with a bushy tail of medium size, the wolverine has beautiful long silky hair of blackish brown colour relieved by a broad ellipse of golden tawny.

Our next example of gluttony is afforded by a fruit-eating bat, one of the group commonly known as flying-foxes; the species in question being a native of India and the Indo-Malay countries as far eastward as the Philippines, and technically known as *Cynopterus marginatus*. From its gluttonous habits, this bat is a great scourge to fruit-growers in the East; the extent of its eating powers may be gathered from the following anecdote recorded by the late Dr. G. E. Dobson, in his time the great authority on bats of all kinds:—

"To a specimen of this bat obtained by me at Calcutta, uninjured," writes this author, "I gave a ripe banana, which, with the skin removed, weighed exactly two ounces. The animal immediately, as if famished with hunger, fell upon the fruit, seizing it between the thumbs and the index fingers, and took large mouthfuls out of it, opening the mouth to its fullest extent with extreme voracity. In the space of three hours the whole fruit was consumed. Next morning the bat was killed, and found to weigh one ounce, half the weight of the food eaten in three hours. Indeed, the animal, when eating, seemed to be a kind of living mill, the food passing from it almost as fast as devoured, and apparently unaltered, eating being performed alone for the sake of the pleasure of eating. This will give some idea of the amount of destruction these bats are capable of producing among ripe fruits."

A close race with this bat in respect to the amount of food devoured is run by the common mole, which is one of the most greedy of all mammals, and will, it is said, perish of hunger and exhaustion if kept without food for a few hours. Indeed, when we remember that the mole feeds exclusively on animal substances, which are much more highly nutritive than those of a vegetable nature, and that it thoroughly digests its food, it seems highly probable that the mole, in respect of gluttony, altogether beats the bat.

Whenever a mole is killed, its stomach is almost sure to be found crammed full of worms, some of which show every appearance of having been swallowed whole. The only record presenting any ap-

proach to a definite estimate of the amount of food a mole will consume in a given time appears, however, to be one furnished a good many years ago by the late Mr. E. R. Alston, an accurate student and observer of British and other mammals. According to this statement, a mole kept in captivity devoured in the course of a single day an amount of food estimated to considerably exceed its own weight. During the first three days of its captivity it consumed three or four dozen earth-worms, a large frog, a quantity of raw beef, the body of a turkey-poult, and part of that of a second, as well as one or two black beetles. It is, of course, a great pity that an accurate record of the weight of the food thus devoured was not kept, but it is quite evident that it was enormous in proportion to the size of the animal by whom it was eaten. And the marvel of it all is that the mole, like the aforesaid fruit-bat, does not appear to become "stodged" after meals of this description, but in a very short time is perfectly prepared—nay anxious—to commence afresh.

Our last instance of voracity in mammals is taken from the cetacean group, and it is of so extraordinary a nature that, were it not attested by a naturalist of high and unimpeachable authority, it would appear absolutely incredible. The species to which the anecdote relates is the so-called killer-whale, or grampus (*Orca gladiator*), a highly carnivorous and formidably-armed creature, black and white in colour, and conspicuous on account of its tall dorsal fin when swimming near the surface. It is a by no means infrequent visitor to our coasts, and is the only cetacean that habitually preys upon warm-blooded animals. In length it varies between about 16 and 25 feet or rather more. No statement as to its weight has apparently ever been published, but, as a very rough estimate, this may be set down as about four or five tons. According to the well-known Danish naturalist, the late Professor Eschricht, one of these killers is known to have swallowed four whole porpoises in succession; while from the stomach of a second, about 21 feet in length, were taken the remains of no less than 13 porpoises and 14 seals in a more less digested condition; the brute having been apparently choked by the skin of another seal, parts of which were found clinging to its teeth. In quoting the latter half of Professor Eschricht's statement, some writers (notably Mr. F. E. Beddard, in his "Book of Whales") omit all reference to the more or less digested condition of the seals and porpoises, so that it reads as though 14 entire specimens of the former and 13 of the latter were extracted from the creature's interior, which would be a manifest impossibility. As it is, the statement that four porpoises were swallowed in succession is difficult enough to credit, seeing that a full-grown specimen of these cetaceans measures about five feet in length. There can, however, be no doubt that the killer is an unrivalled glutton among the larger mammals.

As regards birds, two or three instances must suffice. The common cormorant (*Phalacrocorax carbo*) is the very type of gluttony, and when gorged, these birds, it is said, will not infrequently continue fishing, although too full to swallow another fish. After a full meal, cormorants may frequently be seen sitting motionless on a rock for hours, with their wings half extended, as if "hung out to dry." Soon, however, they recover their appetite, and begin to renew their pursuit of prey. The amount of fish a cormorant will destroy during a season must be enormous, and there can be no doubt that the numbers in which these birds exist on some parts of our coasts forms a very serious detriment to the fishing interest.

Pelicans are likewise extremely gluttonous birds, as are also the great adjutant storks of India, which, till some years ago, formed such valuable scavengers in Calcutta during a considerable part of the year, where they might often be seen standing stolidly on the *maidan* in a more or less completely gorged state. It used to be commonly said in Calcutta that an adjutant would swallow even so large a mouthful as a dead cat at a single gulp, and there is every reason for believing that the statement is founded on fact.

Many instances of gluttony might doubtless be found among the lower animals, and cases of the crocodile and the common pike might be cited among such; but to do this would entail a considerable amount of space without any real increase in our knowledge, beyond that which is conveyed in the foregoing instances.

What the special object of the development of gluttonous habits in certain particular kinds of animals may be is very difficult to conjecture. In the case of the mole, which is a very active animal belonging to an aberrant and specialised group, it is quite easy to understand why an unusually liberal diet may be essential; the difficulty comes in with regard to creatures like the glutton, which differ in no essential features from many of their relatives, who are content with a commissariat of a more moderate type.

The Coloration of Nestling Birds.

By W. P. Pycraft, A.L.S., F.Z.S., &c.

Part I.

In the pages of "Knowledge" for last year, some may remember, I propounded a theory to account for the differences which obtain between the young of nestling birds in the matter of their activity at the time of their escape from the egg. I propose now to follow this up with a few suggestions as to the probable significance of the coloration of nestling birds.

This subject falls under two different heads: (a) the coloration of the body as a whole; and (β) the coloration of definite regions of the body. Under the first section we have all those birds which are nidifugous, or active from the moment they leave the shell, and some nidicolous or helpless birds. These all agree in that they are downy, but they present different types of coloration, all of which, however, belong to the protective resemblance group. Under the second we have some of the downy forms, and those nidicolous or helpless types, which, though generally coming into the world blind, naked, and helpless, yet frequently exhibit brilliantly coloured markings, generally confined to the mouth. These coloured areas belong to another category, and will be discussed in a future paper.

The down-clad nestling, there can be no doubt, represents the more primitive condition, but it is not so easy to determine whether in any case the primitive type of coloration has also been retained, or whether

what appear to be instances of primitive coloration are really cases of adaptation to environment independently acquired.

That the dominant type of coloration among primitive animals took the form of longitudinal stripes seems to be a very wide-spread belief. These stripes are next supposed to have given way to spots, and these latter either became re-arranged to form transverse stripes, or mottlings, or disappeared altogether, leaving a perfectly uniform coloration unrelieved by any markings, or at least any very conspicuous markings such as form a pattern. This orderly sequence seems to imply that these patterns have followed a preordained line of evolution; and that whatever the cause of their origin may have been, the later phases arising therefrom develop independently of the environment. This is by no means a generally accepted view.

Eimer supposes "that the fact of the original prevalence of longitudinal striping might be connected with the original predominance of the monocotyledonous plants, whose linear organs and linear shadows would have corresponded with the linear stripes of the animals; and further that the conversion of the striping into a spot-marking might be connected with the development of a vegetation which cast spotted shadows. It is a fact that several indications exist that in earlier periods the animal kingdom contained many more striped forms than is the case to-day." "This supposition," he goes on to say, "is also supported somewhat by the fact 'that at present strongly spotted forms mostly occur in places with spotted shadows, the longitudinally striped more in grassy regions. . . . Cross-marking is perhaps to be connected with the shadows, for example, of the branches of woody plants—thus the marking of the wild cat escapes notice among the branches of trees.'"

That these several types of markings are, in many cases, direct survivals enjoying a transient existence, like many other vestigial characters, is highly probable, but in others they, with almost equal certainty, represent comparatively recent developments.

Thus the spots in the young lion and the faint traces thereof in the adult female are almost certainly remnants of an earlier and more emphatically spotted phase common to the adults of both sexes. But it is surely possible that in many cases these markings may be remnants of an earlier spotted *immature* stage when the young derived benefit from the protection these markings afforded. In such cases the adults may have been quite differently coloured?

The possibility that the coloration may, in the ancestral forms, have been of one type for the *adult* and another for the *immature* stages, and that the ancestral *immature* stages may be reproduced at the corresponding period of development to-day, is one that seems not to have received fair consideration. Evidence in favour of this view will be submitted presently.

According to the prevailing opinion, we have something like a recapitulation of past types of coloration, the markings of ancestral adult stages being reproduced in the immature stages of to-day. On this assumption we must suppose either that this immature coloration is now of no protective value, or that the descendants of these spotted or striped forms, as the case may be, require the ancestral adult protective colours only during the period of immaturity; or that this coloration belongs to the class of correlated variations and has no significance in a large number of cases.

But even this view cannot be reconciled with Eimer's intrepretation of the significance of these markings. If longitudinal stripes are the result of adaptations to foliage of monocotyledonous plants, and spot marking to an adaptation to foliage of vegetation which cast spotted shadows, then the longitudinal markings of many animals of to-day must be quite out of harmony with their environment, and their survival shows that in these cases at least the correspondence between the markings and the type of foliage need not be a very close one, since the longitudinal stripes developed to harmonize with linear foliage serves equally well amid foliage which casts spotted shadows.

Transverse stripes, at least, it must be admitted, owe their origin to adaptation to totally different environments. Originally developed for the sake of affording protection amid linear foliage, as in the tiger, for instance, they have almost certainly been acquired *de novo* in the case of the zebra, where they serve to protect the animal on account of the *absence* of foliage of any sort.

The contention that longitudinal striping was developed in response to linear foliage is lacking in cogency. Vertical stripes would have served the purpose better, supposing that the direction of the stripes was a matter of prime importance. The widespread occurrence of longitudinal stripes probably depends on a deeper stimulus.

The definite and orderly sequence of colour, which many animals exhibit in the course of development, seems to show that in many cases the markings of the immature stages are really reproductions of an ancestral adult livery. This is well seen in cases where the male and female have a distinct livery. Here the females and young are often precisely similar in dress, and bear a remarkably close resemblance to the adult stages of both sexes of more primitive but closely allied species. Among birds there are many illustrations of this. A large number of animals, however, afford no clue as to whether the colour of the immature individual is ancestral or newly acquired; whether it is an ancestral *adult* or an ancestral *juvenile* coloration. The larval Alpine Newt, for example, is conspicuously longitudinally striped. Even while still within the egg these markings can be seen. There is a median dorsal black stripe which bifurcates on the head, and a lateral stripe, also black. Later, black pigment cells wander into the transparent ground colour, and eventually the black upper and red under surface of the adult is acquired. The stripes of caterpillars are not easily accounted for. Are these independently acquired markings, or inherited ancestral *larval* markings? They certainly can have nothing to do with the adult coloration.

With the birds the problem becomes still more complex, inasmuch as, in the precocious types at least, we may have three separate plumages: (*a*) the nestling; (*b*) of the fully-fledged "immature" stage, which may be the same as that of the female; and (*c*) the adult stage, *i.e.*, the plumage worn by the male only, or by both sexes.

With regard to the "immature" stage it is worthy of comment that, as Prof. Newton has pointed out, "Throughout the class *Aves* it is observable that the young, when first fledged, generally assume a spotted plumage of a peculiar character—nearly each of the body-feathers having a light-coloured spot at its tip—and this is particularly to be remarked in many groups

of the oscines. . . . ." Concerning this fact, which appears to have been first indicated by Blyth half a century ago, we may have more to say on another occasion. Just now we desire to draw especial attention to the plumage of the nestling, which does not appear to have previously occasioned comment.

There seems to be strong presumptive evidence to show that the primitive coloration of young birds took the form of longitudinal stripes. Nowhere are these stripes seen to better perfection than in the young of the Emu. Here, in the very young bird, we find a long, thin, white stripe extending from the head down the back of the neck, and tailwards along the back on either side of the middle line. Below the trunk-stripe a second occurs, but towards the end of the nestling period it is interesting to notice these stripes appear to increase in number. The second, inferior trunk-stripe of the newly-hatched bird now extends forward to join the neck-stripe just described; and beneath the second, now elongated stripe, a third appears, and this runs upwards to form a second

Fig. 1.—The nestling of the Mooruk Cassowary (*Casuarius bennetti*), showing strongly marked longitudinal white stripes on a dark chestnut background. Only faint traces of stripes are present on the neck, but in the Emu they are very conspicuous.

neck-stripe, running parallel with the first; below this third a fourth stripe appears; this extends from the end of the tibia, upwards and forwards along the flanks, terminating at the base of the neck. The continuous neck-stripe, No. 1, breaks up at the base of the skull into a number of dots in this older bird. In the very early stages the legs bear curious mottled markings, but these rapidly vanish.

In the young Cassowary (Fig. 1), at an age roughly corresponding to the second stage of the Emu, only the faintest traces of spots on the head and neck are traceable. On the trunk we find five white bands sharply defined and set off by a darker ground than in the Emu. The fifth corresponds to the leg and flank stripe of the Emu, but is shorter.

In the nestling Rhea stripes also occur, but these are less conspicuous and fewer in number than those of the genera just described. The neck-stripes are obsolete.

The nestling Ostrich appears to differ from the other "Ratites" in having a uniform coloration. The trunk, it will be remembered, presents a curiously grizzled appearance, and this is due to the fact that the tips of the rami of each down feather are produced into long ribbon-like horny processes. But there can be little doubt but that this peculiar structural modification of the down feathers is comparatively recent, since, though these no longer display a pattern, the down feathers of the neck agree precisely with those of the Emu, in that they are coloured so as to form very strongly-marked longitudinal stripes down the back of the neck, while along the front of the neck and the sides of the head these stripes give place to rows of dots.

Apteryx, it may be mentioned, has a uniform grey coloration.

There is no reason to believe that the Grebes are even remotely related to the Ostriches, yet the nestlings of these birds display a precisely similar style of coloration light longitudinal stripes on a dark ground (Fig. 2).

It is interesting to note that while in the nestling plumage of the "Ratite" birds and the Grebes we find a relatively large number of stripes, in all the forms now to be considered the pattern is almost invariably formed by a median and two lateral stripes.

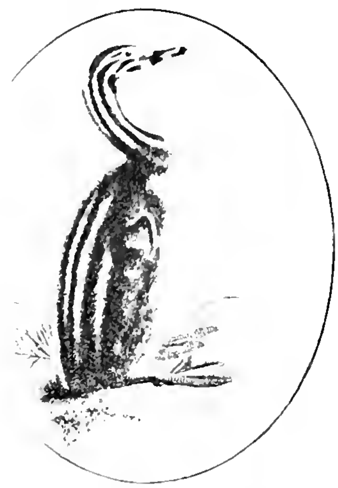


Fig. 2.—The nestling of the Great Crested Grebe (*Podiceps cristatus*) The neck stripes are here strongly marked, as in the Emu.

In some species these stripes are strongly marked, in others barely traceable.

But great variability in this matter obtains, even among the several species of a single family. In the Tinamous, for example, a median stripe along the back, extending forwards up the neck on to the head, and a dark stripe behind the eye, occurs with some frequency. Other of this group are uniformly coloured, or have a dark occipital patch (*Nothocercus*). In *Rhynchotus* the head and neck are spotted, as in the nestlings of the Ostriches.

The game-birds are undoubtedly, as a group, striped when nestlings, though in many this striping is giving way to mottling by the breaking up of the stripes.

The nestling Curassow, *e.g.*, *Crax alector*, is conspicuously banded. The mid-dorsal line is marked with a broad dark chestnut band, tended on either side by a conspicuous white stripe; the band commencing on the head, and widening backwards. The white bars also commence on the head. Again, in the young Argus Pheasant we have a similar dark median band bounded by white stripes. In the young Blackcock (*Lyrurus tetrix*) the general ground colour is buff,

the back of the neck bears a median stripe which bifurcates at the trunk to run down on either side of the middle line in the form of two indistinct lines. The occiput and the rump are of a warm chestnut colour. But the general effect of this pattern is mottled rather than striped. This mottling is more pronounced in the Capercailzie nestlings, and in those of the Pheasant and Partridge; probably this mottling is derived from the breaking up of stripes; the last phase of the striped dress being seen in the nestling Red Grouse.

The nestling stages of the Chardriiformes, or at least the Limicolæ and Lari, appear to have been originally striped. To-day these stripes are most apparent in the Redshank, Woodcock, and Norfolk Plover (*Œdicnemus crepitans*). In the Redshank we find a narrow median dorsal stripe extending forwards up the neck and bifurcating on the crown of the head. On either side of the median stripe are three lateral stripes—these stripes are dark on a buff ground. In the Woodcock the median stripe takes the form of a broad chestnut band. The lateral stripes are wanting.

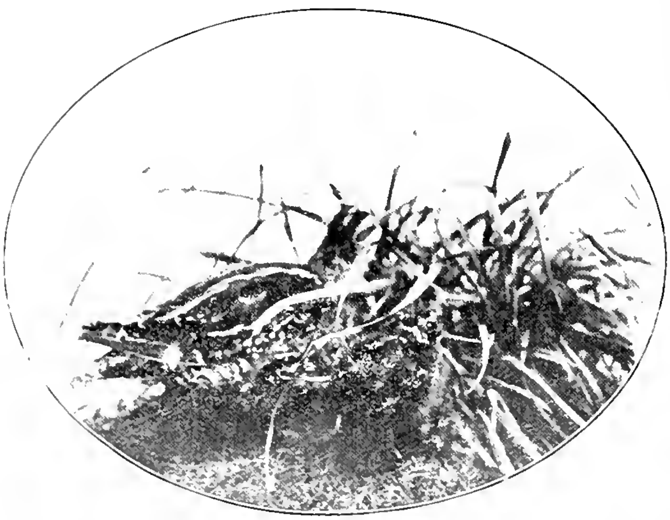


Fig. 3.—The nestling of the Common Snipe (*Gallinago cœlestis*). There is a second nestling between that in the foreground and the adult. Note how the stripes in the adult harmonize with the ribbon-like leaves of the grass.

The Snipe, however (Fig. 3), is distinctly striped. In *Gallinago cœlestis* (the Common Snipe), for example, the general colour of the down is of a rich dark chestnut, relieved by three very distinct white stripes. The adult is also, it may be remarked, longitudinally striped. The Norfolk Plover has the ground colour of the body of a pale yellowish grey, relieved by two narrow black bars or lines along the back, and a black stripe through the wing and down the middle of the head.

In the other Plovers the stripes have broken up to form mottlings as in the Gulls. But the general coloration is obviously adaptive—procryptic. Thus, in the Knot—which breeds in the snow—the down is white, mottled with grey; the young Kentish Plover has the upper parts very pale buff, powdered with black; and so on. The under parts, as in the case of nearly *all* nestlings, are either pure white or nearly so. The Jacana bears strongly-defined narrow black stripes on a bright chestnut ground.

The Gulls, like the Plovers, show both striped and mottled forms, the former being rare. Indeed, so far, the only striped form I have come across is the nestling of the Little Tern. The ground colour in this species is pale relieved by a median and two lateral stripes. From this we pass to the mottled type, and in many cases, *e.g.*, Common Gull, the median and lateral stripes are still plainly visible; the neck, too, is spotted just as in the young of Dromæus, also indicating the derivation of the spots from stripes. The young Sooty Tern is almost unicoloured, powdered with minute white points; and from this we pass to the completely unicoloured and dark young of the Skuas. The Skuas, it is to be noted, are of a uniform dusky colour.

The Gruiformes would appear to have been originally striped, inasmuch as traces of a broad median band are visible in the young Japanese Crane, while the young Bustard (*Otis tarda*) bears a close resemblance to the young Gull, being pale-coloured with dark mottlings.

The young of the Turnices are striped.

The nestling Rails at the present day are all dusky in colour, yet the young of the Black-tailed Water-Hen (*Microtribonyx ventralis*) shows distinct traces of a median and two lateral stripes.

The Anseriformes, like the Rails, have now typically uniformly coloured nestlings. As a rule the upper parts are dark, the central light. But the young of the Mallard and its near allies have their upper parts relieved by light-coloured spots—one over the thigh and one behind the wing. In many Anatidæ there is a strongly-marked superciliary streak, and a streak passing from the lores to the eye, and behind this to the base of the skull. These markings appear to be remnants of an earlier striped condition. The Sheldrakes depart from this type, having a broad dark median band which passes upwards along the neck and invests the whole of the upper part of the head. A dark patch behind the wing gives the semblance of a white streak on either side of this median band. In the Variegated Sheldrake (*Casarca variegata*) the dark median band expands over the shoulders to form a transverse band. Whether this peculiar coloration of the downy Sheldrake is a modification of an earlier striped condition or a specialised condition it is not easy to say, but it seems probable that the latter is the case. The under parts, as in all the other Ducks, are white. The downy young of Swans and Geese, and of Chauna display no markings, and are either pale grey, or pale yellow in colour.

We come now to a number of groups in which the young appear to be invariably uniformly coloured. But, it is to be noted, these young are all nidicolous—born blind and helpless; and it may well be that these have long since lost the ancestral striping. Many are reared in holes, and in those which lay in open nests the striped pattern of the down would probably afford no protection.

The Steganopodes (Gannets, Tropic-birds, Frigate-birds, etc.) have the young clothed in white down.

In the Ciconiæ (Storks) the young may be thickly clothed with long white down, or thinly clad in long thread-like down feathers, *e.g.*, Herons.

In the Tubinares (Petrels) the down is either white (Albatross) or dusky (Petrels). In the Sphenisci (Penguins) it is dark grey or tawny yellow. In the Colymbi (Divers) dark grey. In the Accipitres it is white or grey. In the Striges and other Coraciiformes the down, when present, is either white or grey in colour.

Among the birds, as in other vertebrate groups, longitudinal stripes do not necessarily give place to a

spotted livery, and this to a uniform coloration. In the nestlings of the Emu, Cassowary, and Grebe, for example, the striped dress gives place to one without markings, and this again to a patternless plumage in the adult stage. The Game-birds furnish us with two very interesting stages of development. In some, *e.g.*, Quails, the young are striped; the first pennaceous plumage—as distinct from the downy plumage—may be described as a brown or buff colour relieved by various shades of darker brown arranged in the form of streaks, spots, and bars. The adult plumage for both sexes is similar. In others, *e.g.*, many Pheasants, the striped downy plumage is succeeded by a dress resembling the immature and adult dress of the Quails. This dress is retained by the female, but in the male is succeeded by a more or less resplendent livery. In other Pheasants, *e.g.*, Eared Pheasants (*Crossoptilon*), the speckled dress of immaturity is discarded by both sexes for one of more or less brilliancy.

The same order of coloration, which obtains in the life of the individual in one group, is found in another group only in studying the history of the race. This may appear to be only another way of saying that the history of the species is a recapitulation of the history of the race. But in the present connection, it is to be noted, the most primitive species passes through all the possible phases in the course of its growth, while the "race" to which we have referred is of comparatively recent origin—the Limicolæ to wit. Herein we find striped forms like the Redshank, or the Snipe, mottled forms like the Gulls and Terns and some Plovers, and unicoloured dusky forms like the Skuas and Alcidae, *e.g.*, Guillemots. In the Terns and Gulls the mottled nestling gives place to a brown first plumage, which is succeeded by a more or less unicoloured adult dress worn by both sexes alike.

Longitudinal markings occur but rarely among adult birds. Instances thereof are seen in the Snipe, Avocet, Black-throated Diver, Herons, and Bitterns. Now it is worthy of note that in the Snipe and the Bitterns, at least, these peculiar markings are known to be used for protective purposes. The Bitterns when desiring to conceal themselves adopt a perfectly vertical position, throwing the head and neck upwards and holding the body perfectly still so that the dark lines down the neck harmonise with the dark inter-spaces between the reeds which form its cover. The Snipe reverses this position, holding the head downwards and presenting the longitudinally-marked back so that the tail points directly upwards.

From the Ætiological side it must be admitted we have much yet to learn in the matter of these stripes.

Where both nestling and adult wear a protective plumage, it seems strange that in many cases a distinct livery should be necessary for each stage. But this may be due to the fact that the environment of the nestling is quite different to the normal environment of the adult. The downy young Ringed Plover, for example (*Ægialitis hiaticula*), is almost white with dark mottlings; the adult is buff-coloured above, white below, and barred across the head and breast with black. These bars are apparently protective devices, for while the kahki-coloured body is invisible, the dark bars are conspicuous, but they bear a curious resemblance to mussels, the empty shells of which occur on every tide-wash, where these birds commonly feed.

But there is no need to expect a very close connection between the two stages in the life-history, for while in many cases the stripes of the downy plumage may well be ancestral, and, therefore, of extreme antiquity, the plumage of the species is necessarily of more recent origin, and is determined by the requirements of the environment amid which it has developed.

Finally, we are brought to the question of the origin of the stripes. Their remarkably wide-spread occurrence among vertebrates suggests that they must be due in the first place to some deep-seated physiological activities, which determined the deposition of pigment in certain definite areas, serving either as centres of distribution or as screens for the protection of sensitive regions from excessive light. The reasonableness of this latter view is supported by the fact that these stripes occur with striking frequency in "larval" forms, such as of fish and tailed Amphibia, where the bands of pigment over-run the brain, spinal cord, and lateral line organs. Their occurrence in higher vertebrates would seem to decidedly weaken this hypothesis; but it may be that the ancient fashion of laying down pigment is for some reason or other adhered to in these groups, just as gill arches, no longer useful, are also developed.

It seems hardly likely that these stripes in the case of the birds have been independently acquired, and acquired afresh, too, in each group, at least, in which they occur, solely in response to the need for a protective livery of this particular type. But the adoption of this livery as a method of salvation ready to hand seems probable enough.

The existence of whole-coloured forms seems to have been due either (a) to the suppression of the stripes in favour of a yet more protective dusky livery, as in the case of the young Waterhen (p. 274), where they are just traceable, or of the grizzled covering of the young Ostrich—which retains the original neck-stripes lost in the Cassowary and Rhea—or (β) to the suppression of pigment to secure a white covering, as in the case of birds which, being nidicolous, lie helplessly exposed in open nests to the glare of the noonday sun, and thereby derive benefit from a white covering. That there is some probability in this suggestion is shown by the fact that the Common Buzzard has contracted a habit of erecting a shelter of green boughs above its nest, replacing these as soon as the leaves wither.

The question is full of interest, and demands further study.

REVIEWS OF BOOKS.

Scientific Fact and Metaphysical Reality. It has lately been remarked that in the disturbance of existing theories which has been produced by the determination of new facts in physical science, there are few hypotheses which seem totally unworthy of consideration, and few speculations that are not valid. One might note as an accompanying phenomenon, that the scientific world seems to have been stirred at the same time by a desire to investigate, not the relations of matter and energy alone, but of mind and energy, and to formulate in as exact a manner as its knowledge will allow the relation of mankind to its own fate and destiny. Some such design is apparent in both of two books, of widely different scope, which are before us—"Scientific Fact and Metaphysical Reality," by Robert Brandon Arnold (Macmillan), and "Ideals of Science and Faith" (George Allen) in which the Rev. J. E. Hand collects the essays of writers who approach the problems of man's life or immortality from such widely different standpoints as those that we expect to be assured by a physicist like Sir Oliver Lodge, a biologist like Professor J. Arthur Thomson, a psychologist such as Professor Muirhead, or educationists, theologians, or divines like Professor Geddes, the Rev. John Kelman, the Rev. Ronald Bayne, or Mr. Wilfrid Ward. The value of such opinions, and of such an assem-

blage of opinion. lies in its power to induce people, whose views are as wide as the poles asunder on spiritual matters, to lend an ear to that which other people are thinking. There are many people, sane, high-minded, and cultured, to whom the opinions expressed by Sir Oliver Lodge on the scheme of creation will seem as heretical as any that ever sent a man to the faggot and fire; and there are others, not less kindly, conscientious, or tolerant, to whom the reading given by clergymen of the importance of religious tenets must seem illogical to the verge of puerility. There are beyond these two classes of people—like rays in the *ultra*-violet or the *infra*-red—other thinkers who genuinely believe that it is wrong to teach what they call superstition; and other, and equally worthy people who regard doubt of the Old Testament as blasphemy. If the prospect of seeing their own views stated induces any member of any of these classes of people to buy this book, it will probably lead him to read the opinions that are stated side by side with them; and that is all to the good. In this sense Mr. Hand's collection has a great educational value, and of its interest there can be no doubt.

The other book which we have joined to his for the purposes of this review, "Scientific Fact and Metaphysical Reality," is of a different kind, and demands a different kind of intellectual equipment for its appreciation. It is, as we take it, an attempt to state, if not to reconcile, some of the eternal differences which are to be recognised between man's conception of the material universe and the instinctive denial of his own insignificance in it. "The stars . . . by their double scale, so small to the eye, so vast to the imagination, seem to set before man the double nature of his character and fate," wrote R. L. Stevenson. Mr. R. B. Arnold endeavours to disentangle the paradox of man as a mere collocation of living cells; and of man created by God for immortality as he has believed himself to be. Mr. Balfour, in his recent Presidential Address to the British Association at Cambridge, sought to exhibit the contradiction between the physicist's theory that motion was matter, and man's instinctive disbelief—something akin to Nature's abhorrence of a vacuum in anything which should persuade him that matter was a mere state of motion: that

> The stately palaces, the solemn temples,
> The round world . . .

could dissolve like the baseless fabric of a vision, and leave not a wrack behind. Mr. Arnold's intention is not to exhibit the paradox, but to reconcile its antitheses: to show, in short, that there may be a scientific reason, not for the grudging admission of the possibility of a superior Being's existence, but for the acknowledgment of a Divine purpose and a Divine future for man's soul. We are not sure whether Mr. Balfour's paradox was sounder than most paradoxes, since the very latest theory of the physicists is, after all, but a tentatively built model of the universe which is of the most temporary value. Theories are only to explain things we do not understand. They are not immortal truths. And if Larmor's and Thomson's and Lodge's modern cosmogonies are only temporary structures, we are not very sure of the value of anyone's theories of God and immortality. But the theories are always interesting, and Mr. Arnold's exposition and his philosophy are exceptionally so.

The Science and Practice of Photography.—By Chapman Jones, F.I.C., F.C.S., F.R.P.S. Fourth edition. Rewritten and enlarged (London: Iliffe and Sons).—The new edition of this well-known text-book is in many respects better than the earlier editions. It has been not merely brought up to date, but re-written, so that, although it is arranged on the same general lines as before, it is practically a new book. Of those parts that are obviously new, we notice especially the chapters on the modern organic developers, the nature of their constitution, and the methods of their use; the most recent lenses and the principles involved in their construction; the nature of the developable image; the newer printing methods, such as the Velours-Artigue, gum bichromate, ozotype, and Ostwald's catatype processes; and chapters on photographic measurements and the more exact testing of photographic plates, besides pages on sensitometry, actinometry, shutters, the illumination of the dark room, and many other subjects. In some cases where the subject dealt of is on the border line of what may be called pure photography, references are given to enable the student to continue his study of the matter if he should desire to do so. Although the book is essentially a student's book, it is also a practical guide, and those whose knowledge of chemistry and optics is slight will find at least a very appreciable help towards understanding the principles of their work as dealt with here in the few pages devoted to the exposition of the fundamental principles of these sciences as applied to photography. The general arrangement of the volume, with the significant headlines to the pages and copious index, facilitate reference to any desired subject. It is an invaluable book.

The Heart of a Continent.—The publication in a cheap edition of Colonel Younghusband's book, "The Heart of a Continent" (John Murray), comes at a most opportune moment. Not only because its author, as the hero of the Thibet Mission, has a special claim on the interest of the public just now, but because the travels described in "The Heart of a Continent" took place partly in the scene of the present Russo-Japanese War, as he visited Mukden and Kirin, and travelled through Manchuria. It would be difficult to have a more agreeable cicerone than Colonel Younghusband; his fine intelligence illumines all he touches, and the entire absence of prejudice with which he treats all he describes gives it a special value. We will quote as an instance the following comparison between the English and Russian Armies: "An English soldier is perfectly right when he has shaken down on active service, but in barracks he produces the impression that his dress is his main interest in life. A Cossack, on the other hand, whenever one meets him, looks as if he were ready to buckle to and fight then and there, and certainly dress or appearance is the last thing in the world he would trouble his head about."

A History of South America.—In his "History of South America" (John Murray), Mr. Charles Edmond Akers has admirably executed a most useful piece of work. Up till the appearance of this book, there was no general history of South America in existence; and the seeker after information had to glean his facts with pain and toil from writers of divers authority and nationality. Mr. Akers has provided in one moderate-sized volume a concise yet readable history of the South American Republics down to the present day. He has dealt in greatest detail with the events of the last fifty years, but the emancipation of Spain's Colonies is briefly described, and an introductory chapter relates the history of the Spanish Conquest. Subsequently Mr. Akers deals separately and at length with the histories of individual States. In a narrative that is of necessity so condensed there is not much scope for picturesqueness. The story is one of cruelty and oppression, bloodshed, and revolution, but it is told tersely and dispassionately, though Mr. Akers is a little too much inclined to judge medieval adventures by the standards of to-day. Here, for instance, is his estimate of the Spanish Colonists: "The national character had been formed under malignant influences, and the outcome was narrow-minded fanaticism, carelessness as to human life, despotic conduct towards all of lower rank, an absence of any impartial sense of justice. A lower standard of the relation of man to man, a narrower conception of public morality, it would, even in those days, have been difficult to find anywhere. It was from the scum of this fanatical population that the first Colonists came." Mr. Akers goes on to describe very briefly the ever-to-be-regretted destruction of Inca civilisation, one of the greatest tragedies of history. The chapters that follow are a remarkable achievement in their concise and well-proportioned marshalling of facts in which one dominant personality after another comes to the front and is conspicuous; and here great interest is added to the book by the portraits of leaders and presidents from Simon Bolivar onwards—men with strongly-marked features and rough exteriors. "Glancing back over the period which this history covers," says Mr. Akers, in conclusion, "there is everywhere the sense of human sacrifice, the all-pervading smell of bloodshed, no matter whether the country under review is Argentina, Brazil, Uruguay, or Paraguay. If these Republics would suppress their military establishments, and rid themselves of the armaments they have collected, tranquillity would be ensured. They are fond of posing as nations while still in their swaddling clothes. The possession of great stores of war material is a temptation to try conclusions with their neighbours." But even in this respect Mr. Akers thinks improvement is noticeable, and there is a growing desire for internal and external peace. What is necessary for the consolidation of peace is the "adequate administration

of justice throughout the Republics, protection of civil rights, and a more liberal system of education. No great ability, no extraordinary effort, no costly expenditure of money is necessary to achieve these results.

Across the Great St. Bernard. Mr. A. R. Sennett is possessed of a facile and fluent eloquence, which he exercises with much effect in "Across the Great St. Bernard" (Bemrose and Sons). Alpine climbing is a subject which naturally affords scope for picturesqueness, and if the reader can overlook a too exuberant diffuseness of style, he will find much enthusiasm, much interesting matter, and a genuine gift of observation on the part of his author. Mr. Sennett is a dauntless cyclist, and, wherever it was possible, his journey was performed by that means. Among many curious points of interest he raises is that of the curious physiological phenomenon, peculiar to high altitudes, known as mal-de-montagne. Its symptoms are described as follows: "Within an hour of the hospice I was seized with mal-de-montagne. . . . My throat was dry, my head ached, as did my limbs; in the most unexpected manner I dropped in the snow, with an overpowering desire to sleep there and then." This form of seizure has been investigated by Professor Mosso, of Turin. He found that it generally began at a height of 12,000 or 13,000 feet. The symptoms are an extreme lassitude, with panting for breath, and sometimes vertigo, with nausea, and a tendency to syncope. Professor Mosso is of opinion that it is due not only to a deficiency of oxygen in the blood, but also to a lack of carbonic acid caused by diminution of air pressure, and he relieved a sufferer from mountain sickness by giving him carbonic acid gas to breathe, but M. de Thierry, on the other hand, states that carbonic acid gas exists in nearly the same proportion at a height of 12,000 feet as it does 6,000 feet lower. It is curious that Mr. Sennett was recommended by "the good father of the hospice at Simplon, if we felt faint, to eat the snow! Because," said he, "you may become faint for lack of oxygen, and mountain snow contains much air."

An Optical Dictionary.—"The Optical Dictionary" (Gutenberg Press), edited by Mr. Charles Hyatt-Woolf, is a useful glossary of optical and ophthalmological terms. It is intended for the use of students and others; and includes, in addition to strictly optical terms, a large number of words relating to photography and instruments of precision, as well as mathematical terms, and a certain number of French and German words in common use.

A German Grammar.—"Whitaker's Modern Method of Learning German" (Whitaker and Sons), by C. W. Whitaker and H. G. Braun, is intended primarily for the use of students who are teaching themselves. It contains much useful matter, a simplified grammar, examples of correspondence and conversation, exercises and translations. In our opinion the authors are mistaken in supposing that a student could obtain any idea how to pronounce the German language from the accompanying phonetic spelling in the reading lessons. What open-minded person, for instance, would imagine that "fair-gneá-goonks-rry-zer" represented the correct pronunciation of "Vergnügungsreise"? While the spelling Eesch for Ich and leesh for lich are surely unnecessarily misleading.

Trees.—The first volume on Buds and Twigs, Professor Marshall Ward's series on "Trees" (Cambridge University Press), is well calculated to fulfil the purpose for which it was intended—that of providing students of forest botany with a guide to the study of trees and shrubs from the point of view of the outdoor naturalist. The author seeks to rectify the existing neglect of the older methods of observation of the living plant, "which rendered the study of botany so exhilarating to the naturalist of pre-laboratory days." It is a most attractive little volume, filled with excellent illustrations. It is so far exempt from unnecessary technicalities as to make it suitable for the use of the amateur student of Nature, while at the same time it also includes an introduction to the study of systematic botany and morphology, and to what its author describes as "the expert study of forest botany."

The Story of the World.—A wise selection of an elementary text-book of history for Cape schools has been made by the Government in "The Story of the World" (Wm. Blackwood), by Miss M. B. Synge. It is published in five volumes, each one complete in itself. The first, which is in some ways the best of the series, tells the story of the world up to the time of Julius Cæsar. The method [illegible] has been to deal only with well known events and [illegible] to impress themselves readily on a child's mind; these are described in a pleasant, popular style, and [illegible] by a historical narrative. The illustrations are attractive and instructive. The four successive volumes deal with the periods from the Roman Empire to the Renaissance (Vol. II.); from the Reformation to the Seven Years' War (Vol. III.); and from the American War to Waterloo, "The Struggle for Sea Power" (Vol. IV.). A volume on "The Growth of the British Empire" (Vol. V.), covering the period from Waterloo to 1903, completes the series.

Photography.—"How to Photograph with Roll Cut Films" (Hazell, Watson, and Viney, Limited), by John A. Hodges, F.R.P.S. A good manual for the amateur; should be very popular. Price 1s. net.

A New Catechism (Watts and Co.), by Mr. M. M. Mangasarian, Lecturer of Independent Religious Society of Chicago, is an attempt to give, in question and answer form, a popular commentary upon current beliefs, phenomena, and institutions. It deals with such subjects as Reason and Revelation, the Church Creeds and Clergy, Death and Immortality. It appears to be a sincere attempt to face the essential facts of life.

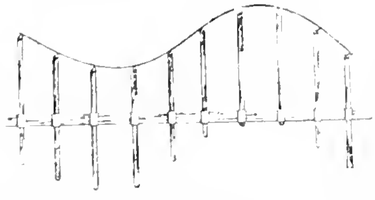
Key to Godfrey and Siddons' Geometry. Mr. E. A. Price has done a useful piece of work in preparing a "Key to Godfrey and Siddons' Geometry" (C. J. Clay and Sons, Cambridge University Press Warehouse). A key is essential to a work of this kind, and will treble the usefulness of an excellent Textbook of Geometry for Preparatory Schools.

Philosophy of Herbert Spencer. Mr. W. H. Hudson has revised and partly rewritten his "Introduction to the Philosophy of Herbert Spencer" (Watts and Co.), which now appears in a cheap and popular edition. It is intended as a guide to the study of the Synthetic System, rather than a summary of it; it also includes a biographical chapter. It is written in as clear and popular a style as is consistent with the subject.

Second-Hand Books. From Messrs. John Wheldon and Co. we have received a copy of their newly-issued list of miscellaneous books, in which we notice the various branches of science are well represented.

Physical Apparatus.—Messrs. F. E. Becker and Co. (W. & J. George, Limited, Successors) have sent us a copy of their new list of apparatus in the various departments of Physics, including Sound, Light, Heat, Magnetism, Electricity, Mechanics, &c. This exhaustive catalogue consists of over 600 pages and some 4000 illustrations. One of its noteworthy features is that the requirements of science teaching in this country and its Colonies are always kept in view, and the articles listed cover the latest developments in their subjects. The method adopted in the list itself, together with the completeness of the index, is such as to make reference to it simple and expeditious.

Brooks' Flexible Curves. Mr. W. J. Brooks, of Fitzroy Street, sends for our inspection the devices which he has patented for assisting draughtsmen to draw experimental curves. These devices are three in number—a flexible strip of celluloid or steel provided along its length with tabs which can be held down by the fingers, a steel



strip to which any shape can be given by means of a stiff-hinged linkwork that is attached to the tabs and holds them permanently in position, and an elaboration of a similar principle suited for drawing long curves. In this third pattern light wooden cross-bars hinged to the tabs slide through brass spring-clamps, and are thereby held friction-tight against a long wooden bar running like an abscissa of the curve. These devices, together with one or two modifications and accessories of them, are as practical as they are ingenious, and will be found of great service to architects, designers, engineers, or experimenters in mathematical physics and to draughtsmen generally.

MICROSCOPY

Conducted by F. Shillington Scales, F.R.M.S.

Coccidae.

With Notes on Collecting and Preserving.

By Alice L. Embleton, B.Sc.

(*Continued from page* 251.)

From this brief sketch of some of the points in the life-history of *Comys infelix*, it can be gathered that very special microscopic methods are required to do such a piece of work on Coccid parasites. It has been found that the eggs can be sectionised while still in the abdomen of the fly. The best fixing reagent has been found to be Gilson's fluid (the formula for which will be found in a footnote), used cold. The specimens

Formula for Gilson's Fluid :—

Nitric Acid, 46°	19·5 cc.
Glacial Acetic Acid	5 5 cc.
Corrosive Sublimate	23 75 cc.
Alcohol, 60 per cent.	125 cc
Distilled Water	1100 cc.

were left in nearly half-an-hour, then washed very thoroughly in 70 per cent. alcohol, and so gradually taken to absolute alcohol, cleared in cedar wood oil, and fixed in paraffin (not too hard—certainly not more than 52 degrees melting point). The sections give best results for nuclei of eggs when stained by the iron-alum-hæmatoxylin method, with eosin as the second stain ; the nuclei in such preparations show their structure very clearly, and the mounts are permanent. The youngest little white larvæ are best seen in water or dilute glycerine, the tracheæ, then remaining full of air, show up dark and well-defined. For some structural points it is well to treat them with very weak osmic acid, or, better still, expose them for a minute or two to the fumes of osmic acid over the mouth of a bottle containing it. It is inadvisable to use alcohol with these larvæ, as they shrink, and very little can be ascertained from such specimens. Some aqueous stains take well on these larvæ, but on the whole those mounted in water or dilute glycerine, unstained, seem the most satisfactory, though they have the disadvantage of not being permanent.

The crystal-containing envelopes are best seen by polarised light. The microchemical tests to prove these crystals to be uric acid also need special care and methods. Many of the other points in such an investigation as this must be confirmed by means of serial sections, to prepare which it has been found best to fix the specimens in Gilson's fluid, the nitric acid of which serves to soften the chitine. Various stains may be used, but to see nuclei the iron-hæmatoxylin and eosin will be found to be as good as any—or with Grubler's orange G instead of eosin.

The above gives an inadequate account of the methods of investigating some of the finer points in the developing and life-history of a Coccid parasite, but, perhaps, it would not be out of place here to give some general directions for collecting and preserving *Coccidae* themselves. Such directions have been given over and over again by entomologists of all countries for the collecting and preserving of *Coleoptera*, *Lepidoptera*, etc., but *Coccidae* are not, and never have been, favourite insects for the collector, and so it may not be superfluous to give here some notes as to the best methods to be employed for collecting and preserving these interesting but much-neglected creatures. They differ so widely from other insects that special methods are necessary. There is a great field for the collector in Coccidology, as collections have been made from very few parts of the world, for, whereas very representative collections exist of other insects from North and South America, most European countries, Africa, New Zealand, and India, yet the *Coccidae* are practically unknown. The collections that do exist are at best very local and very incomplete. This is all the more extraordinary when one remembers how destructive *Coccidae* are, especially in tropical countries, where they are conspicuous on almost every plant. This neglect has not come about because these creatures are in any way specially difficult to deal with, for they are remarkably easily collected, and immense numbers can be packed in very small space, and sent through the post without harm befalling them.

As regards localities, though *Coccidae* are found north and south of the fortieth parallels, yet they cannot be looked upon as abundant. Search for them will be best rewarded in the warmer temperate zones, and in the tropics, where there is a vast unworked field of investigation that would richly reward the entomologist. They are found chiefly on trees and shrubs, ferns and palms ; much collecting may be done by those who receive plants from the tropics, and importers have great opportunities not only for collecting these insects, but also for preventing the introduction of harmful species.

In collecting it is best to simply gather portions of the host plant without disturbing the parasites, and to get plenty of the material, and both sexes where possible. In preserving it is well to avoid alcohol, for specimens collected in this way are often useless and cannot even be identified ; however, it is sometimes useful for the softer species, but, as much as possible, *Coccidae* should be preserved dry. Flat card boxes serve the purpose best, though envelopes are useful ; yet boxes have the advantage of saving any parasites that may emerge ; a full description of locality, date, etc., should be written on each. Tin boxes being air-tight give rise to mould, and should therefore be avoided. With those specimens which are too fragile to preserve well, a rough sketch of their form should be made. To keep permanently, place the *Coccidae* in glass tubes, with cotton wool stoppers until the specimens are quite dry, and then later put in india-rubber stoppers.

To mount for the microscope, it is first necessary to boil away all the soft parts with caustic potash, and then mount in Canada Balsam, after the usual washing dehydrating, and clearing procedure.

A Means of Marking the Position of Objects upon the Cover-Glass.

It is often necessary to mark upon the upper surface of the cover-glass the position of objects mounted beneath it, but it is by no means easy to do so without

some mechanical aid. I have found that the simplest, and perhaps easiest, method is to carefully bore and file out a sound cork, or portion of a cork, so as to fit not too tightly over the end of the objective, leaving a fairly substantial margin to give comparative rigidity. Through this margin is bored a small hole pointing downwards and inwards towards the optical axis, and holding a fine sable-brush. The marking liquid may be Brunswick black, or asphalte thinned to a suitable consistency with turpentine. It is then only necessary to adjust the brush up or down in its obliquely-placed hole so as to give a ring of the requisite size, to rack the objective down towards the cover-glass until the brush is in contact with it, and to rotate the cork ring which holds the brush so as to describe the necessary circle. The rotation should be in the opposite direction to the hands of a clock so as to avoid unscrewing the objective on the one hand, or unscrewing the front lens on the other, and for the same reason this direction of rotation should be adhered to in putting the cork on to the objective or in taking it off. Too much black must be avoided, and the brush must be very carefully pointed, or the ring is not made neatly and satisfactorily. Another method is to fit a cork on to the objective in the same way but to allow it to project somewhat, and to press into it a small brass ring with a carefully ground edge. This ring is painted with the marking fluid and brought down gently upon the cover-glass, but it is difficult to make neat rings by this means, and to be of much use the brass ring and the consequent hole in the end of the cork have to be much smaller than the bore which takes the objective, so that the cork is not easy to file out, and the projecting ring interferes with the field of the objective with low powers, and with the focussing with high ones.

Glare when using a Vertical Illuminator

Workers on metal specimens who use the vertical illuminator are aware of the glare which is constantly present in the field of view, and often to such an obtrusive extent as to seriously diminish sharpness of definition and perception of detail. This is generally due to reflections from the inside of the mount of the objective. This glare may be greatly reduced in fact, for practical purposes, eliminated, by placing an Iris diaphragm close to the source of light and reducing the aperture through which the light passes, by means of this diaphragm, to such a point as will remove the objectionable glare. It will be found that this will not affect the brilliance of the actual image, for only precisely the amount of light that can be usefully utilized, no less and no more, will pass through the objective. A similar arrangement in connection with ordinary photo-micrography removes the glare which is so often objected to, from the inside of the body of the microscope.

Notes and Queries.

J. M. Dunbar, East Griqualand.

Several correspondents kindly answer my query last month by recommending Hassall's "Adulterations Detected" (Longmans, 1857) as a book which deals with the microscopical examination of adulterated foods. It contains over 200 microscopical illustrations. I am also referred to Battershall's "Food Adulteration," price 15s., which has photo-micrographic plates. This last is an American publication, but may be had in London at Spon's.

J. Carrington, East London, S.A.

I would recommend you to get Lewis Wright's "Popular Handbook to the Microscope" (1895), published by the Religious Tract Society at 2s. 6d. This is quite elementary, and contains chapters on some common microscopical objects. Also Cross and Cole's "Modern Microscopy" (1903), published by Baillière, Tindall, and Cox, at 4s. This deals most clearly with the microscope and its use on the one hand, and with mounting methods on the other. If you have any special difficulty I shall be glad to help you with it.

J. P. Hodges, Grangetown, Yorks.

The resolution of *Amphipleura pellucida* has long been a favourite task with amateurs, but it is really not so difficult as it seems. The first requisite is to have the diatoms mounted in a medium of suitable refractive index, such as realgar, though monobromide of naphthalin will do. The objective should have an aperture of about 1·25 or more, and if the condenser is also an immersion one the result will be the more satisfactory. Search the slide and pick out a good diatom—they vary more than would be imagined. Carefully centre the condenser with a low power by means of the iris diaphragm, then bring the lamp-flame into the centre of the field, using the edge of the flame and keeping the tail-rod central. Focus the flame sharply with the condenser. Now change the objective to the $\frac{1}{12}$th, and without altering mirror or lamp recentre the flame and refocus it. The transverse striations should now be seen pretty clearly, and will not be improved by closing the diaphragm. But if not successful proceed as follows: See that the lamp is exactly opposite the microscope, and the mirror adjusted so that the lamp-flame lies vertically in the centre of the field. Adjust the slide so that the diatom also has its long axis vertically in the centre of the field. Make all other adjustments as before, taking pains with the centring. Now beneath the condenser put a stop which has one slit in it reaching from the edge to the centre, and about $\frac{1}{8}$ inch wide, placing the stop so that the slit lies to the front of the condenser. A slight tilt of the mirror in its gymbals may be necessary to bring the striations clearly into view, and a little adjustment within narrow limits sometimes works wonders, but the principle is to throw a narrow and very oblique beam of light longitudinally down the diatom. Of course the image does not represent the real structure of the diatom, and that is a point which has been much discussed. The resolution of diatoms is certainly not a waste of time; I question if anything so soon teaches a microscopist how to use his instrument to best advantage, or if any other study has given as much impetus to the demand for better objectives, better corrections, and better apertures, and so helped to bring about the comparatively recent great advance in this respect.

Microscopical Material.

Mr. Alfred Death, of Bury St. Edmunds, has kindly sent me for distribution a quantity of Echinus spines. The cutting and rubbing them down for mounting is, as Mr. Death says, somewhat tedious work, but they make beautiful objects for either directly transmitted light or annular illumination, generally known as "dark-ground." Mr. Death gives the following *résumé* of his method of procedure: (1) Make transverse section, as of any hard tissue. (2) Rub one side quite smooth upon a hone, preferably Water-of-Ayr stone. (3) Fasten smooth side upon glass slip with Canada balsam. (4) Grind section on glass upon hone until sufficiently thin. (5) Remove section from hone by warming over spirit lamp. (6) Pass through alcohol into clove oil and mount in Canada balsam. I shall be pleased to send one or two of these spicules to any reader who sends me a stamped addressed envelope, together with the coupon appearing in another part of this issue, and it will be a convenience to me if applicants will enclose in the envelope a small piece of tissue paper in which to fold the minute spicule.

[Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.]

The Face of the Sky for November.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.55, and sets at 4.32; on the 30th he rises at 7.44, and sets at 3.53. The equation of time is a maximum on the 3rd, the Sun being 16m. 21s. before the clock.

Sunspots and prominences have been numerous of late; at the time of writing five groups of spots are visible.

The positions of the spots, &c., with respect to the equator and poles may be derived by employing the following table:—

Date.	Axis inclined from N point.	Centre of disc, N of Sun's equator.
Nov 1 ..	24° 39′ E.	4° 11′
,, 11 ..	22° 33′ E.	3° 6′
,, 21 ..	19° 41′ E.	1° 54′
Dec. 1 ..	16 6′ E.	0 38′

THE MOON:—

Date.	Phases.	H. M.
Nov. 7 ..	● New Moon	3 37 p m
,, 15 ..	☽ First Quarter	0 36 a.m.
,, 23 ..	○ Full Moon	3 12 a m.
,, 30 ..	☾ Last Quarter	7 38 a.m.

THE PLANETS.—Mercury is in superior conjunction with the Sun at the beginning of the month, and towards the end of the month he becomes an evening star, setting about an hour after the Sun.

Venus is an evening star setting about 5.45 p m. on the 1st, and about 6.15 p.m. on the 30th. Towards the end of the month the planet will be observable after sunset, but low down in the S.W. The disc is gibbous, and has an apparent diameter of 13″·0.

Mars is a morning star situated on the confines of Leo and Virgo, rising at 2 a.m. on the 15th.

Jupiter is in an extremely favourable position for observation, and is the most conspicuous object in the evening sky looking S.E., being visible from sunset until early morning.

The equatorial diameter of the planet on the 1st is 50″·0, whilst the polar diameter is 3″·2 smaller.

At 11 p.m. on the 19th the planet is in proximity to the Moon, being only 1°½ to the North.

The configurations of the satellites, as seen in an inverting telescope at 10 p.m., are as follows:—

Day.	West	East.	Day.	West.	East.
1	21	43	16	2	134
2	2	413	17	13	24
3	431	2	18	3	124
4	43 ⊙	2	19	3241	
5	132	1	20	432 ⊙	
6	413	2	21	4	132
7	4	123	22	412	3
8	1 1	3	23	42 ○	13
9	42	13	24	413 ○	2
10	3 1 1	2	25	43 ○	12
11	3	2 1 4	26	3421 ○	
12	● 32	4	27	321 ⊙	
13	● 1 3	4	28	○	1324
14		1234	29	1	34
15	12	34	30	2 ○	134

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Saturn is on the meridian about 1½ hours after sunset; hence this is the best time for making observations; the brightness of the planet is diminishing in consequence of increasing distance from the earth.

The ring appears widely open and we are looking down on the northern surface at an angle of 16°; on the 5th the polar diameter of the ball is 15″·6, whilst the major and minor axes of the outer ring are 39″·4 and 11″·0 respectively.

The planet is in quadrature with the Sun on the 7th.

The moon is near the planet on the evening of the 14th.

Uranus is unobservable, setting shortly after sunset.

Neptune rises about 11 p.m. near the middle of the month; his position in the constellation Gemini will be seen on reference to the chart appearing in the January number.

METEORS:—

The principal showers of meteors during the month are the Leonids and Andromedids. Watch should be kept for Leonids after midnight of the 14th and 15th, when the moon will have set.

Date.	Radiant.		Characteristics.
	R.A.	Dec.	
Nov. 14-16	150°	+ 22°	Swift, streaks. (Great Leonid shower.)
Nov. 17-23	25°	+ 43°	Very slow; trains. (Great Adromedid shower.)

Encke's Comet:—

The re-discovery of Encke's comet by photography with 3½ hours exposure at the Königstuhl Observatory has been confirmed by a later photograph taken at the same place, which establishes its identity beyond doubt. The comet is described as extremely faint and diffuse. Its approximate position on November 1 is R.A. 23 hr. 17 m., Dec. + 26° 51′, or a little east of β Pegasi; it is moving in a direction W. by S.

THE STARS:—

About 9 p.m, at the middle of the month, the following constellations may be observed:—

ZENITH . Cassiopeia.

SOUTH . Andromeda, Pisces Cetus; Pegasus, Aquarius towards S.W.

WEST . Aquila, Cygnus, Lyra a little north of west, Corona N.W. setting.

EAST . Auriga, Perseus, Pleiades, Taurus; Aries to the S.E.; Orion rising S.E.

NORTH . Ursa Major, Ursa Minor, Cepheus; Draco a little west of north.

Minima of Algol will occur on the 8th at 11.50 p.m., on the 11th at 8.39 p.m., and on the 14th at 5.28 p.m.

TELESCOPIC OBJECTS:—

Double Stars:—η Cassiopeiæ 0^h 43^m, N. 57° 17′, mags. 3½, 7½; separation 5″·7. Binary star.

λ Arietis 1^h 52^m, N. 23°·6′, mags. 4, 8; separation 37″. Components white and blue; easy with power 20.

η Persei 2^h 44^m, N. 55°·28′; mags. 4, 8; separation 28″. The brighter component is orange, the other blue. There are also several other fainter stars very near.

Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL and E. S. GREW, M.A.

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The Conservation of Mass.

By ALFRED W. PORTER,

Fellow of, and Assistant Professor of Physics in, University College, London.

THE principle which is the basis of all analytical chemistry is expressed by saying that whatever combinations or separations are effected in different materials the total amount of material present remains constant. The amount of material referred to in this statement is not measured by its volume; indeed, in many cases, this undergoes considerable change. The measurement is made by a balance, and the actual process of measurement consists in counterpoising the substances under examination—both in the free and combined states—against given "weights"; the "weight" so obtained is then taken as being a measure of the quantity of material present.

We are not now concerned with the illustration of this very familiar principle, nor with the question of its practical truth, which is undoubted. Every chemist trusts in its truth when he expects the results of his analysis to add up to 100 per cent. But as considerable interest is to-day felt in the possibility that the law is not completely satisfied, we intend to examine as simply as possible the experimental means by which its failure might be ascertained.

However, in the first place, it is important to have clear ideas as to what the problem really is. Some confusion of thought about it is prevalent. This confusion arises from the current confounding of mass and weight. Can we take the weight of a body as being proportional to the quantity of material in it? My housekeeper tells me it is so. Two pounds of sugar weigh twice as much as one, and there is twice as much sugar in them. Unquestionably so—from *her* point of view; but *we* must look at things a little more accurately than my housekeeper does.

When any material is placed in one pan of a balance it presses on it with a certain force. This force is said to be "due to gravity"—a statement, however, which does not add much to our knowledge. It would be much more explicit to say it is due to the earth; for there is every reason to believe that if the earth were to disappear the force would vanish too. It is this force which is scientifically defined as being the *weight* of the body. Now if anything has been proved with certainty, it is that the weight of a body is not always the same. Hang it on a spiral balance; the extension of the spiral spring is less if the experiment is made near the equator than near the poles. Or, better still (for a spiral spring is not very sensitve), place the body on one of the extremely ingenious spring balances which have been recently devised, and which consist simply of a horizontal fibre of quartz supported at one end—a cantilever, in fact. These are of wonderful sensitiveness and constancy also; the same force at the free end produces the same amount of bending every time. But a given fragment of material placed on it will produce a different deflection near the earth's equator than if the experiment is made near the earth's poles. It will be different if the apparatus is high up a mountain than at the sea-level. There is no constancy of *weight* even for the same body in the same state; this is acknowledged by all. So that, after all, it cannot be the weight that is being taken as a measure of the amount of material when the principle of the conservation of material is asserted to be true. The confusion arises from a peculiarity of the ordinary balance. The material is placed in one scale pan upon which it presses down. Weights (*i.e.*, standard blocks of material) are placed in the second pan, upon which they press down. If the two just counterbalance one another, and if the balance is accurate, they are said to be equal to one another. The comparison made here is between the turning power of two *weights*, and if the arms of the balance are of the same length, equality of turning power involves equality of the weights themselves. Even in the most accurate analyses, then, although it is the *weights* of the constituents of any body which are currently taken as being equal in the aggregate to the total weight of the body they compose, yet it must not be forgotten that all the weighings are made in the same locality.

Suppose now that the constituents are weighed on a sufficiently sensitive spring balance, and that some of them are weighed near the equator and some near the polar regions. If what we have said above about the variation of weight with positions on the earth is true, the sum of the separate weights will not equal the weight of the compound or mixture. The total weight of a body is admittedly not conserved, but depends upon the conditions under which it is weighed.

This variation cannot, however, be detected by an ordinary balance. Two weights that counterbalance at one part of the earth will balance everywhere else; in other words, though the pull of the earth on each undergoes variation, it varies in the same proportion for each; and, consequently, if they are equal anywhere, the equality is universal. It is this peculiarity of an ordinary balance which has led to the popular notion

that the amount of material in a body can be measured by its *weight*. If any other kind of sensitive balance had been employed it would soon have been realised that this is not legitimate unless it be assumed that the quantity of material in a body varies according to the part of the earth on which it happens to be placed.

If weight, then, is not a satisfactory measure of the quantity of matter in a body, can we find any property that is?

If we were concerned only with matter of the same chemical kind—for example, iron—and exactly the same in all respects except that there was a bigger volume of one than of the other, nobody would hesitate to measure the quantity by volume. Matter would be bought by the cubic centimetre, or cubic foot, or the quart. Two quarts would always represent twice as much matter as one. But the world is "full of a number of things," and it is not easy to explain exactly what you mean if you say that there is as much material in a certain volume of water as in a certain block of lead. What is the criterion of equality in such a case as this when the material is of different kinds? In commerce, a certain volume of iron is given in exchange for a much smaller volume of gold. In some sense, then, these different volumes are taken as being a measure of equivalent quantities of the two materials; and if a fixed relation were preserved between these quantities, a perfectly sound scientific system could be founded on such a basis of equivalence. But familiarity with market fluctuations would soon breed contempt for such a system; it would be absolutely of no use for scientific purposes. It has been agreed to measure quantity of material not in the commercial way; not even by its weight, which is nearly satisfactory; but by another dynamical way, which, at any rate, till recently, was thought to make the principle of the conservation of material precisely true under whatever circumstances the quantity of matter is measured.

We will explain this method.

When Sir Isaac Newton thought out his Laws of Motion, he perceived that every change of motion is brought about by the influence of one body upon another, and, moreover, that this influence is a mutual one. When two billiard balls strike, the velocity of *both* is changed; each influences the motion of the other. A horse gives motion to a cart, but the cart simultaneously retards the motion of the horse. The main part of the motion of the moon is controlled by the influence of the earth, and reciprocally the moon modifies the motion of the earth.

Think now only of the simplest possible case, viz., that in which the mutually influencing bodies move along the same straight line; two billiard balls, for example, moving without spin. When they strike, the speed of one is increased and that of the other is then always retarded. Measure, or (since this is not always easy to do, and we do not wish to introduce here the complications of actual measurements) imagine measured, the *change* of velocity of each. The ratio of the changes, so far as all experiment has succeeded in obtaining it, is the same for the same two bodies whatever the previous velocities may have been. For two billiard balls it would usually come out as numerically equal to unity; whenever it does so *the masses of the influencing bodies are defined as being equal*. If the ratio of the changes of velocity is not unity, the *ratio of the masses of the two bodies is defined as being* INVERSELY *as the ratio of the changes of velocities, whatever it may be*. For example, if the balls be called A and B, and A increase its velocity (due to the influence of B) from 4 to 10 units, while B *diminish* its velocity (due to the influence of A) from 6 to 2 units, we have

$$\frac{\text{Increase of velocity of A}}{\text{Decrease of velocity of B}} = \frac{6}{4} = \frac{\text{Mass of B.}}{\text{Mass of A.}}$$

Hence in this hypothetical case B has $1\frac{1}{2}$ times the mass of A, and no matter what the circumstances of the influence may be, this relation is found to be constant for the same two bodies A and B; for example, if A's velocity increase by 12 units due to B, then B's will decrease 8 units due to A. The more massive body has its velocity changed to the less degree; hence, mass, as we have defined it, is a measure of the reluctance of the body to be disturbed. A fly alighting on a cannon ball scarcely affects the motion of the latter; a cannon ball striking a fly sweeps it apparently irresistibly before it. In each case the motion of the ball is changed but little because its mass is so enormous in comparison with that of the fly.

The supposed constancy of the mass of a body under every condition makes the mass an eminently suitable means of measuring the quantity of material in it, and is universally adopted as such. Thus, in the example given above, B is said to contain $1\frac{1}{2}$ times as much matter as A. This mode of measuring matter corresponds to considering the quantities equal when the same kind of substance is present in equal volumes; but for different kinds of substances the quantities may be equal when the volumes are very different. A cubic foot of lead has about 11.35 times as much matter or mass in it as a cubic foot of water.

In a later number we will show the relation between mass and weight, and we will then be in a position to explain the nature of the evidence that has in recent years been brought forward in the endeavour to prove that the principle of conservation is not precisely true.

The Radio-activity of Chemical Reactions.

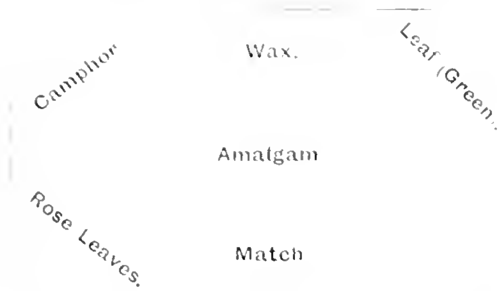
By A. F. Burgess and B. Ingram, B.A., F.C.S.

It is, of course, a well-known fact that every chemical reaction is attended by the evolution or absorption of energy in some form or another. That a chemical equation does not adequately represent a chemical reaction has recently been further attested by the work of Colson, who has found that when a supersaturated solution of sodium sulphate is made to crystallize it gives out n_1-rays. A mixture of aluminium, sulphate, and potassium sulphate does not give out n_1-rays until crystallization (*i.e.*, with formation of alum) is started.

Much interesting research has been done on this subject, and the more substantial proof has been supplied by Landolt and Heydweiler, who have succeeded by means of a balance of high precision in detecting losses in chemical reactions by radio-activity. In fact, the discrepancies, which Stas constantly encountered in his weighings when engaged in his classical research on the "Indestructibility of Matter," may now be satisfactorily accounted for on the proof that, in chemical processes, the loss is due to certain emanations.

Our first experiment (which was entirely speculative) consisted of placing in a light-tight box the

following substances arranged in the positions as shown in the diagram. These were covered by a sheet



of ordinary note-paper, and on the top was placed (film downwards) a photographic plate. We left it from July 28 until September 6 (40 days).

Fig. 1.—July 28-Sept. 6, 1904. 40 days.

It will be observed that the general illumination comes from the centre of the plate directly over the sodium amalgam into which water had been allowed to trickle. The obstacles were pieces of plain and perforated zinc, copper, and tinned iron. In order to investigate the cause of this action we exposed our materials for a period of twenty-one days to the radio-active effects of gas mantles, and then tried their effect, as before, for ten days (September 6 to September 16). When the plate was developed it appeared quite clear. Incidentally we observed that unused gas mantles have precisely the same effect as the used gas mantles.

Our next experiments were conducted in an iron box, blackened and made thoroughly light-tight. A section through the apparatus is given in Fig. 2.

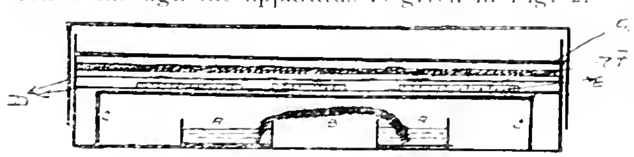


Fig 2

A, vessels containing chemical reagents.
B, wool connecting them.
C, iron support.
D, note-paper.
E, obstacles.
F, plate (protected) with film downwards.
G, thick sheets of red paper.

Our first experiment with the zinc-copper couple beneath the support C produced the accompanying result (see Fig. 3). The exposure lasted eleven days

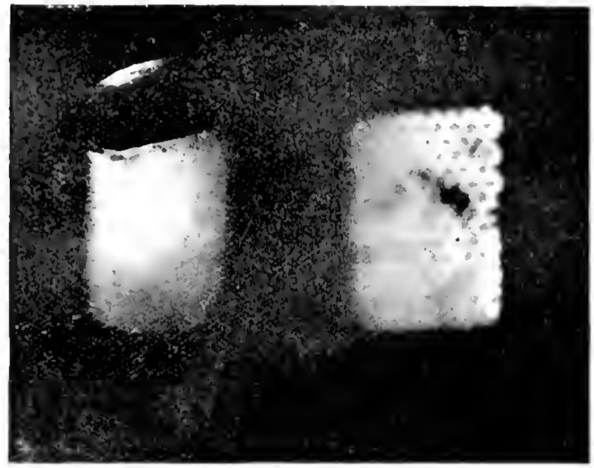


Fig. 3.—Sept. 20-Oct. 1, 1904. 11 days. Cu Zn in Sulphuric Acid.

(September 20-October 1). Both the pieces of zinc have become sources of light, thus producing an effect entirely different from our other results.

It may be stated here that the pieces of zinc used had not been in use before for any previous experiments. After an exposure of thirteen days phosphorus in water gave no result whatever. Our next plate is the result

Fig. 4. Sept. 23-Oct. 3, 1904. 10 days. Ammonia and Hydrochloric Acid (fuming).

of exposure to fuming ammonia and hydrochloric acid. In spite of our precautions to the contrary the liquid managed to crawl up to the plate and affect it as shown above.

It then occurred to us to try the effect of a double reaction, such as takes place when calcium carbide is treated with water.

(1) $CaC_2 + H_2O = CaO + C_2H_2$
(2) $CaO + H_2O = Ca(OH)_2$

After an exposure of only two days the plate was developed with the accompanying result. The light portion was the part immediately over the vessel containing the calcium carbide. The lines were on the

paper in which the photographic plate had been wrapped. Another piece of perforated zinc served as the obstacle. It can be faintly seen with the shadow of the iron support running across it almost parallel to the edge of the print.

We next tried the effect of rapidly evaporating some ether in our apparatus. We used a piece of bromide

Fig. 5. Oct. 8-10, 1904. 2 days. Calcium Carbide and Water. Obstacles: Zinc (one piece plain, one perforated).

paper, carefully protected* from actual contact with the vapour, and placing a penny as the obstacle, we endeavoured to obtain an "instantaneous" photograph by a three-hours' exposure.

Fig. 7 shows most clearly the effect of a chemical reaction. Here the piece of perforated zinc can be

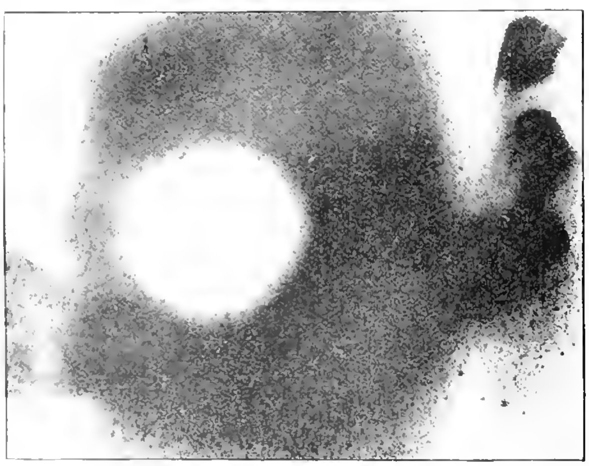


Fig. 6. Oct. 4, 1904. Exposed for three hours to ether vapour. Obstacle: Penny.

plainly distinguished *through* the iron arm of the support. The obstacle on the right is a plain piece of zinc. The plate is the result of the slow decomposition of hydrogen peroxide, $H_2O_2 = H_2O + O$, lasting over a period of thirteen days.

Our last effort was to expose a plate to some eucalyptus oil for a period of thirteen days.

* Ether blackens bromide paper on development.

We are not aware that any chemical change goes on when this oil is left alone, nor could it have evapor-

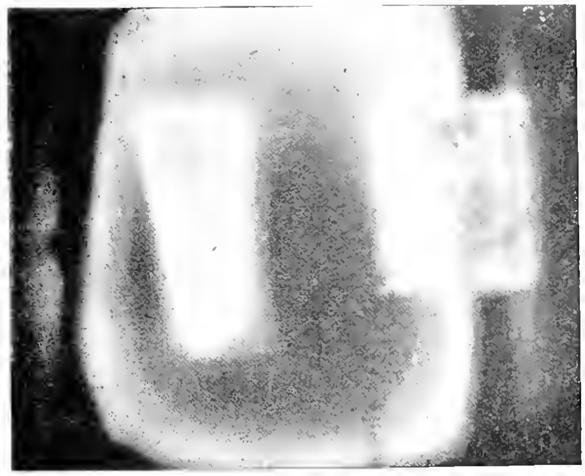
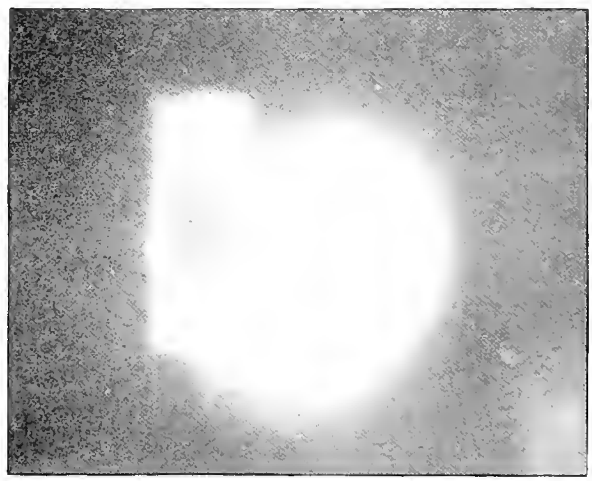


Fig. 7.—Oct. 8-21, 1904. 13 days. H_2O_2.

ated to any extent, seeing that the box was closed the whole time; yet the plate shows some action of some



Oct. 8-21, 1904. 13 days. Eucalyptus oil.

kind, and we leave it to the efforts of the readers of "KNOWLEDGE" to suggest a satisfactory explanation.

NOTE.—Will Mr. A. F. Burgess communicate his address to the Editor.

Spectrum Analysis.—It is not quite easy to classify "An Introduction to Spectrum Analysis" (Longmans, Green), by Dr. Marshall Watts, which is something between a text-book and a work of reference. Perhaps its best title is the one that has been found for it; and it may be confidently recommended to students who wish to take up the study of spectroscopic methods from the beginning. It is divided into two portions; the first of which describes spectroscopic work and discusses the uses of instruments; the Fraunhofer lines of the solar spectrum, the meanings and implications of the "Zeeman Effect," and of observations in stellar spectroscopy generally; the Michelson echelon diffraction grating; and the work of Professor Hale with the spectro-heliograph. The second part of the book embraces some hundred and eighty pages of catalogue of spectra.

The Vital Earth.

By Grenville A. J. Cole.

The slowness of the processes of mountain-building and denudation, the coldness of common rock, and the manifold signs of activity, on the other hand, in the organic kingdoms, have conspired to make us regard our planet as a dead mass, the destiny of which is now concentrated in that of the human race.

There is no doubt that man and his movements have the supremest interest for ourselves. Ethnographers have discussed the influence of environment, and have seen the geographic cradle, as it were, reflected in the characters of a tribe. But, again and again, the migrations of peoples, with customs and manners ready formed, have shown us that man may finally impress himself on his new surroundings, instead of being forced into their mould. Our prevalent classical education, moreover, ignoring natural phenomena on the one hand, and the long struggles of prehistoric man upon the other, tends further to fix our attention on the dominant position that we have attained.

But is the earth on which we move so very lifeless after all? If we construct a diagram to show how much of this ball, 8,000 miles across, is accessible to our direct enquiries, we are at once brought face to face with the enormous possibilities of the interior. We are familiar with the circulation of water, for example, between the atmosphere and the uppermost and disintegrated layers of our rocks; but we may well ask if all the water, and all the gases, were successfully extruded at the period of the consolidation of the crust. This period, again, is still in progress; the crust is far from stable, and grows by additions from below. Substances, till now occluded, may be given out, when passage is afforded to them during the movements of the upper layers; others may become incorporated in the crust, and may ultimately be brought within our reach, in their later modifications, upon the surface.

Prof. Suess, of Vienna, has recently pressed home upon us the distinction between permeating superficial fluids, as defined by Posepny, and those that are in reality nascent and come to us from below. We still meet in newspapers, and in many scientific text-books, the theory that the waters of volcanoes originate from inroads of the sea; and the influence exercised by this view is emphasised by the clearness with which Prof. Suess has found it even now necessary to stand out against it. "The steam of volcanoes," he says,* "cannot arise from infiltration from the surface, and such infiltration is clearly out of the question in the case of the carbon dioxide. Whence, then, do these substances arise? They proceed from the deeper inner regions of the globe, and are the outward signs of that loss of gases, which began with the first consolidation, and which is not completely over, though localised at certain points and lines. In this way the oceans and the whole superficial (*vadose*) hydrosphere became separated from the body of the globe. Volcanoes are not fed by infiltrations from the sea, but the seas increase in volume as the result of each eruption."

* "Ueber heisse Quellen," Address to the Society of German Naturalists and Doctors at Karlsbad, 1902 (*Prometheus*, XIV, 1903, p. 226).

Suess points out that this proposition is not new; yet it needs repeated affirmation. From some points of view, in fact, the interior of the earth, with its concentrated metals under high temperatures and pressures, is still young and potent, a planet still capable of giving off light-rays of its own, were its stony envelope removed. The incandescent glow of the material ejected from volcanoes brings us, as Tschermak has indicated, near to the cosmic forces that are common to the systems of the stars. The liberation of gases and "emanations" in the past is no real measure of what remains occluded in our own day. Combinations, moreover, may be possible at the existing high temperatures in the interior, which lower temperature and relief from pressure may in time convert into other and even startling forms.

The object of the present paper is to ask for a suspension of judgment in regard to several questions which geological instructors are apt to pass over as well proven. A wise review of this matter appears in the last edition of Sir A. Geikie's "Text-book of Geology" (1903, pp. 351-8), where many useful references to published papers will be found. We gain new interest in the water that permeates volcanic rocks from the amazing eruptions of Martinique and Saint Vincent in 1902. The stories of poisonous gases and fiery exhalations soon gave way before scientific examination; the burning and scorching effects proved to be due to hot volcanic dust, sent forth in such quantities as to practically exclude the common air. No flame or ordinary combustion was possible until the dust-cloud relaxed its first closeness and intensity. Moreover, its very texture and continuity seem to have been due to the evolution of water-vapour from each of the myriad particles that were ejected simultaneously from the vent. But it is difficult in such catastrophic examples to realise what is actually going on, and what gases are being liberated so abruptly from the parent earth. The study of the vapour-jets and hot springs that remain in volcanic areas for centuries after activity in the ordinary sense has passed away, has given us an impressive picture of the immense streams of matter passing from the inner rocks into the hydrosphere. The prevalence of carbon dioxide is especially striking. Not only at the famous Grotto del Cane near Naples, but at the far more accessible Grotte du Chien at Royat in the Department of the Puy-de-Dôme, we may become immersed in a bath of this dense gas as it oozes from the pores of solidified volcanic ground. The opening of a bottle of natural mineral water, though the "sparkle" in different species occurs in very different degrees, brings us into touch in a more homely way with the unexhausted vitality of the earth. Probably no one attributes the carbon of the gaseous compound thus brought to the surface to the decay of ancient vegetation within the crust. Yet the case of petroleum is probably similar; and here the material is generally referred to as of an organic origin. A combustible material, however strange its mode of occurrence and emanation, seems to suggest from the outset fossil forests and old swamps, and it is almost impossible to persuade "practical men" that carbon exists in the earth apart from coal-seams. The very fact that petroleum is in some cases successfully distilled from Carboniferous shales is, moreover, commonly held to prove its organic origin in all areas. Carbon and carbon-compounds, however, must have existed on our globe long before living things arose upon the surface, and it is no mere speculation to suppose that much of the material remained unavail-

able on account of its combination with metals in the hidden depths.

The occurrence of graphite offers many interesting suggestions. In Siberia and in the Western Alps, beds of graphite may be traced into strata that retain recognisable vegetable remains. Weinschenk*, who has given special attention to this matter in recent years, believes that the graphitic anthracite of the Alps—which one may see, for example, collected for fuel on the summit of the Little St. Bernard—passes into graphite as the result of the intrusion of the adjacent granite. In the Archæan region, however, of the frontier of Bavaria and Bohemia, Weinschenk† finds no sign of an organic origin for the beds and lens-like masses associated with the ancient gneiss. He urges that the graphite is here deposited from gaseous exhalations, which were connected with the inflow of granite in the area. Gruner's experiments on carbon monoxide in 1869 lead Weinschenk to regard this gas as a very probable source of carbon in the gneisses. It appears that iron ores at 300° C. decompose carbon monoxide with deposition of graphite; the little known metallic carbonyls, moreover, may also be looked to as furnishing carbon in a volatile form. Such substances, with carbon dioxide and water, are pictured as saturating the rocks in contact with the invading mass, and as taking advantage of any planes of easy penetration, during the folding of the ancient series. Mica-schists, with the easy partings offered by the prevalent mineral, might thus become impregnated in a special degree; while cavities provided by earth-movements would serve as chambers of deposition. As years go on, we shall probably learn more and more of the products yet to emerge from the earth's unknown interior. While we are on the verge of gaining some ideas on elemental transmutation, we may even look forward to the exhalation in due time of substances unknown to us in our present geological age. Time may be an important factor in the internal processes of our vital globe; and who shall say that senility has yet set in? Is it not at least a fair speculation that life itself may be a phenomenon expressing a particular phase in the history of our globe? Life may not be a merely external reaction, limited by temperature, and controlled by cosmic law upon a cooling and indifferent planet. May we not in time see some return towards the conception of the great Earth-mother, fostering her children from within, stimulating them daily against attack, reviving them, perhaps, in hours of danger, and fitting them to cope with future changes by changes in her own heart's core?

* Abhandlungen der k. bayer. Akademie der Wissenschaften II. Cl., XXI. Band, 1900.

† *Ibid.*, XIX. Band, 1897.

Awards to the Wellcome Chemical Research Laboratories, London.

The Committee on Awards of the Louisiana Purchase Exposition, St. Louis, have conferred upon the Wellcome Chemical Research Laboratories the distinction of a grand prize and three gold medals, in recognition of the importance and educational value of the chemical and pharmacognostical researches conducted in these laboratories under the direction of Dr. Frederick B. Power.

Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

König's Three-Colour Process.—This process, only recently published, has attracted a good deal of attention, and deservedly so, for it not only illustrates a new principle as applied to the purpose of colour photography, but has been worked out by its author to a successful issue. Whether or not it will be found to fulfil the conditions necessary to establish itself as a standard or commercial process, only time can prove. It is a triple film method, but differs from those previously proposed, in that each colour is printed out by light.

Many of the organic dye-stuffs yield on reduction colourless or leuco-derivatives, which can be oxidized to reproduce the original colour with more or less facility, and exposure to light generally facilitates this oxidation. By choosing a dye of a suitable colour, and one that yields a leuco-derivative of sufficient stability to withstand the necessary operations and yet is sensitive enough for practical printing purposes, it is obvious that the colour may be obtained directly by exposure to light under the negative, and the necessity for a relief produced by the chromated gelatine process, or any similar indirect method of getting the required distribution of the colour, is obviated.

These leuco-derivatives were found to be useless by themselves or in an inert film, as they then gave only poor and flat images, but the presence of a nitric acid ester was discovered to overcome this difficulty. Pyroxylin being an ester of nitric acid a collodion film is employed, and mannite nitrate is very suitable for further augmenting the sensitiveness. The removal of the excess of the leuco-derivative after exposure was at first a difficulty, as ordinary solvents and acids were found useless for the purpose. But monochloracetic acid is effective, and it is used as a ten per cent. solution.

The process consists in coating a suitably surfaced paper with a one-and-a-half per cent. collodion, to which the leuco-derivative and other desirable materials have been added, exposing under the appropriate negative until the colour is sufficiently intense, fixing in the chloracetic acid solution, washing, and dipping into a gelatine solution that contains chrome alum and drying. The print is again dipped into the gelatine solution and dried to effectively protect the collodion film during the application of the collodion that is to furnish the second colour. This routine is repeated for the second colour and again for the third, and the print is finally varnished.

The method of judging when each colour is correctly printed is not very clear, as it seems impossible to adjust the depth of tint of the films that are sealed up by the subsequent coatings. The process is apparently rather tedious, as there are three collodion films, six gelatine coatings, and a final coating of varnish to dry. The obvious objection to the number of films because of their combined thickness is probably invalid, as the collodion and the gelatine solution used are weak and the films they give correspondingly thin. A real difficulty I should have expected to be due to the action of the chloracetic acid on the gelatine films under the collodion film that is being subjected to the fixing

operation, but doubtless this possibility has received attention.

Lumière's Starch Method of Three-Colour Photography.—This process, which was described about six months ago, contrasts very emphatically with Konig's method in the simplicity of the necessary manipulation. No colour screens or filters are needed, there are no films to stain, no colours to produce of the correct intensity to match one another, no separate negatives with subsequent printings, but merely one exposure, ordinary development, and then, instead of fixing, the silver image is dissolved out and the remaining silver salt reduced to the metallic state. But if the work of the photographer himself is simple, it is because of the complex character of the prepared plate, and presumably it is the difficulties of manufacture that have led to the delay in putting the prepared plates on the market. The plates are made by selecting starch granules of from 15 to 20 thousandths of a millimetre in diameter, staining quantities of them red, green, and violet respectively, drying them, mixing them so that neither colour predominates but that the whole presents a neutral gray tint, and spreading the mixture on glass one layer thick. The interstices are filled in with a fine black powder, and the layer is fixed and protected by a coat of varnish. On this is put a film of suitably colour-sensitized emulsion. Exposure is given through the glass, and the subsequent treatment of the plate is as described above. The dyed starch granules form an irregularly grained three-colour screen, which serves the double purpose of taking and viewing.

It is easy to describe such a process, but besides the obvious mechanical difficulty of preparing the plates, there must be many compromises made before the result can be passably satisfactory. The best three colours for the exposure are not the best three for viewing the picture, but in this case they have to be the same. If the stained starch granules are mixed to the most neutral tint possible, it appears that a perfectly orthochromatised sensitive film would be necessary. The imperfections of the film in this matter must be neutralised as far as possible. Indeed, the difficulties of which the photographer is relieved have to be overcome by the manufacturer, and in this particular case they are so many and complex that if it had not been stated that results have been obtained in the manner described, we might very well doubt the possibility of it.

Lantern Demonstrations.—Optical lanterns are so often unskilfully used, even on occasions when the best methods of demonstration might well be expected, and sometimes when they are handsomely paid for, that I wish to take the present opportunity of calling attention to one matter now, and shall refer to other matters at a subsequent date. At scientific lectures it is often necessary to introduce a small piece of apparatus on to the stage of the lantern, such as an electroscope or thermometer, for example, in order that its changes during an experiment may be clearly seen by the audience. The lecturer must have ready access to the lantern to superintend or conduct the experiment. When there is no special provision for such demonstrations, the usual way is to fix up a sheet at the back of the platform, and to have the lantern at one side near the front of it. The lantern has to be tipped up to get the image above the level of the lecture table, its stage therefore, is sloping, and apparatus put on it is very likely to shift its position, if not to fall over; the lecturer when at the lantern is sure to be between the sheet and some of the audience, however he may contort his body to get it out of the way; and as the lantern is tipped up, and generally to one side of the sheet, the disc of light is far from circular, and it is impossible to focus more than a small part of the object, even when it is flat, at any one time. All these and other annoyances may be overcome by the use of a small translucent screen on the lecture-table with the lantern centrally placed behind it so as to give a two or three foot disc, taking care that the lantern is properly protected by screens to avoid the possibility of any light that may leak out from it glaring into the eyes of the audience. The lecturer would find this arrangement much more convenient, and the audience would see the projected image much more clearly, the fact that it would be smaller than otherwise usual being an unqualified advantage.

Phoebe, Saturn's Ninth Satellite.

By A. C. D. Crommelin.

There is no question that the discovery of Phoebe reflects the greatest credit on Prof. W. H. Pickering. It was no mere accident, but the result of a deliberate search for additional satellites which he has been carrying on for many years. Even after the existence of the satellite is known it is a tedious matter to identify it on a photograph, but to have discovered it in this way—one little grey dot among myriads of others—is, indeed, astonishing. Prof. Pickering explains the long delay in the confirmation of the original announcement by the fact that his attention was called off by his photographic work on the moon. In addition to this the unexpectedly large eccentricity of the orbit (0.22, four times that of our moon) made it much more difficult to detect Phoebe on the plates taken at Arequipa in 1900.

At length the idea occurred to him to extend the search to a greater distance from Saturn than he had hitherto thought sufficient, and there, in fact, Phoebe was found, near elongation, some 33′ from its primary, indicating a distance of nine millions of miles.

It was not till a few months ago that the most surprising feature of all—the retrograde motion round Saturn—was discovered.

It is well known that in double star orbits it is frequently impossible to say whether the upper or the lower half of the orbit is nearer to us; in the case of some bright stars, like Sirius or α Centauri, the spectroscope has settled the matter, but in other cases it remains insoluble. In the same way we could not tell from a single year's observations of Phoebe whether its motion was direct or retrograde, and it was even found possible to construct a direct orbit which would represent the observations of 1898 and 1900 without any large errors. But in 1904 the position of Saturn has changed so much that the direct and retrograde orbits are at once distinguishable, just as the question would be settled in the case of a double star if we could transport ourselves to a very distant standpoint, where we might view the system in another direction; and it is to be noted that the retrograde motion is indicated in two entirely different ways: (1), by comparing the position of the Perisaturnium, or nearest

point of the orbit to Saturn, in the different years; (2), by leaving the eccentricity out of account and simply considering the change of tilt of the apparent orbit, treated as a circle. Prof. Pickering deduced it by method (1), and I got the same result from method (2), being obliged to treat the orbit as circular since I had not enough material to determine the eccentricity.

The fact that (1) and (2) are in complete accord establishes the retrograde motion beyond reasonable doubt, and renders highly improbable the suggestion made by Mr. Monck and others that the satellite observed in 1904 is a different body from that observed in 1898 and 1900, both moving in direct orbits. For it would be a most astonishing coincidence that two independent satellites moving in direct orbits should be so related that a single retrograde orbit of large eccentricity should be capable of exactly simulating the movements of both.

The retrograde motion is still further confirmed by the fact that the observations indicate that the node of the orbit *advances* (about 3° per annum), since the node moves in the opposite direction to the revolving body.

The sidereal period of Phoebe is 547 days, or exactly $1\frac{1}{2}$ years; the period from "New" to "New" is about 26 days shorter, or 521 days; this is also the average period between successive inferior conjunctions as seen from the earth. Thus is it alternately east and west of Saturn, for about 260 days in each position; while its maximum elongation considerably exceeds half a degree, as compared with 10′.4 for Japetus, 11′.3 for Jupiter's satellite IV., the two greatest elongations of satellites previously known. The mean distance of Phoebe from Saturn is exactly eight millions of miles, while the greatest and least distances are $9\frac{3}{4}$ and $6\frac{1}{4}$ millions. The inclination of its orbit to that of Saturn is about 5°.

Even as seen from Saturn, Phoebe would only appear like a tiny star of the fifth or sixth magnitude; so that it might remain undiscovered for ages by imaginary Saturnians, just as Uranus, although faintly visible to the naked eye, was not discovered till 1781.

Its diameter is estimated to be somewhere about 150 miles, slightly greater than that of Jupiter's satellite V. The two satellites, though similar in size, present a startling contrast in their motions; V. is remarkable for its proximity to Jupiter and its short period of 12 hours; also for the very rapid motion of the perijove, which makes two entire revolutions in a year; this arises from the action of Jupiter's equatorial protuberance. In Phoebe's case the perturbations produced by Saturn's oblateness and by the other satellites must be insignificant. The solar perturbations, however, assume an importance which they do not possess in the case of any other satellite except our moon. Prof. Newcomb estimates that the coefficient of the evection is about 4°, three times the amount for our moon; this will shift Phoebe some $2\frac{1}{2}$′ as seen from the earth, and will, therefore, be a readily measurable quantity. The apse moves round Saturn about $\frac{3}{4}$° annually in the same direction as Phoebe. It is thought that the effect of Jupiter's action on Phoebe's motion will also be appreciable; there is a good deal of matter here awaiting mathematical treatment, and it is not impossible that some further light may incidentally be thrown on the theory of our own moon.

Prof. Pickering gives some speculations *re* the bearing of Phoebe's retrograde motion on the nebular hypothesis. He supposes the planets to have once formed rings of matter revolving round the sun; then since the inner portion of the ring would revolve the quickest, when the ring coalesced into a planet the part next the sun would be moving quickest, *i.e.*, the planet would be rotating in a retrograde direction. Thus he supposes that all the planets originally had retrograde rotations, and next asserts that this state of things was unstable owing to the action of solar tides, which tended to turn the planet over so as to make the direction of rotation the same as that of revolution. This point will need careful examination by our leading mathematicians, but if we assume it provisionally it will explain a good many things about the solar system. Phoebe is supposed to have been born in very remote ages, when Saturn rotated backwards; while Saturn was turned over before the birth of Japetus and the inner satellites. It also appears that distant satellites, like our moon, Phoebe, and Japetus, are compelled by the sun to move in planes near the primary's orbit; while near* satellites, such as those of Mars, Jupiter, Saturn (7 inner), and Uranus (presumably) are in the equatorial plane of their primary.

The theory explains the retrograde motion of the Uranian and Neptunian systems by supposing that the solar tides have been too weak at such great distances to turn the planets over, though Uranus would seem to have been turned about half way, and Neptune one-quarter of the way. Thus the new theory tends to bring these outer planets into line with the others, and to remove a difficulty which had always been felt with regard to the application of the nebular hypothesis to them. Going to the other extreme, the slow rotations of Mercury and Venus, which are now accepted by many astronomers, would likewise find an explanation in solar tides, so that these would seem to have left their traces on the system from one end to the other. They were doubtless much more powerful in distant ages, when the planets were larger and more diffused than they are at the present day.

* The word "near" is to be understood relatively to the size of the primary, compared with which Jupiter's satellites are all much nearer to him than our moon to the earth.

The Inner Nebulae of the Pleiades.

By Dr. Max Wolf, F.R.A.S.

The original plate of the accompanying photograph was taken by the writer with the "A" lens of the 16-inch Brashear twin telescope, on December 22, 1902, with five hours' exposure. The plate was carefully backed with a black coating, so that the well-known halation circles do not appear round the bright stars. The accompanying photograph has been enlarged three times from the original negative. In order to bring out the inner nebulæ it was necessary to greatly prolong the process of copying, so that the fainter outer nebulæ have become over-darkened. The extremely curious straight lines of nebulous stream are very well seen. The inclined and partly doubled stream near Electra* is a defect and not a true nebula. We see that all the brighter stars of the Pleiades are systematically connected by streams of nebulous matter beautifully fine in structure.

*Electra is the nebulous star 2·8 inches from the west side of the plate, and 3·7 inches from the south side.

WEST.

NORTH.

SOUTH.

EAST.

The Inner Nebulæ of the Pleiades.

Sunspot Variation in Latitude.

By E. Walter Maunder, F.R.A.S.

Dr. Lockyer's object in his two letters would appear to be twofold. First, to indicate his dislike of a short note on page 159 of the July number; second, to make a certain claim for himself. Under the first head he has failed to point out a single inaccuracy in the note, though his two letters together exceed it in length more than ten times. I think the note stands vindicated as having presented in nineteen lines the gist of three long papers with truth and remarkable conciseness. Under the second head, Dr. Lockyer introduces much wholly irrelevant matter, but avoids the only two questions which really bear on the point of his claim. Did he make use of a certain paper, and if so, did that paper already contain the result which he claims as his own, definitely and explicitly set forth? Dr. Lockyer does not and cannot deny that he did use the paper in question, and that it did so contain that very result. Whether that result confirms or contradicts Spoerer's Law, is a matter which has no possible bearing on Dr. Lockyer's claim to it. Nor is it, in this connection, of the smallest significance by whom or under what conditions the paper was written, which Dr. Lockyer used, and wherein he found the result in question.

The Herschel Obelisk near Cape Town.

We are indebted for the accompanying photograph to the courtesy of Mr. W. H. Wesley, to whom it was sent by Mr. Clement Jennings-Taylor, from whose covering letter to Mr. Wesley, we are permitted to make the following extracts:—

It may interest you to know that my house is close to where Herschel's old residence stood; his monument standing about 100 yards in front. I am sending you a good amateur photograph of the obelisk taken by a friend, Mr. S. Rutherford, as I thought you might like to reproduce it. The obelisk, which by the way forms the crest of the Claremont Municipality, is very plain, and covers a small round pedestal of granite. This pedestal can be dimly seen in the photograph, together with the "H" forming part of the four initials cut deep into and round the same. On the top the date is deeply cut, "1838," to see which one has to crawl into the hole. A brass tablet is shortly to be fixed on one side, and I understand that the Council is willing to find half the cost of railing the monument round, provided the remainder can be raised by subscription—some £100 to £150 *in all*. It has been neglected of late years, and seeing that the obelisk, with some 50 or 60 feet of ground round it, is public property, it seems a pity some protection is not arranged for. The ground about is at present open, except for the schools just in front, but as the estate has been cut up and mostly sold in lots, it will soon be built over, and then will come the danger of damage. The monument is placed astronomically true N. and S., the front or opening being due south. A pretty view of the Devil's Peak is seen above, to the left, and the oak trees make an excellent background. The weather marks on the stone are also wonderfully reproduced. Strange to say, a great many people residing in the district and in Cape Town do not know of the existence of the obelisk, and a greater number probably do not know who Herschel was or what he did, so the lack of interest in and care of the memorial stone may be somewhat accounted for. I was showing it to an acquaintance one

day, when he surprised me with "Oh, Herschel! that's the chap who invented the steam engine, isn't it?" Half an hour in my little observatory opposite enlightened him on the subject, though he confessed that "he didn't think it much of a money-making business."

Ancient Egypt.—The "Short History of Ancient Egypt" (Constable) which has been compiled by Percy E. Newberry and John Garstang is almost as concentrated as Bovril is said to be by its advertisers. But whereas Bovril contains 90 per cent. of water, there is positively no dilution of any sort or description in this most useful little work. Mr. John Garstang is known to readers of "Knowledge" by the Beni Hasan excavations, some account of which appeared in the August number; and his name, like that of Mr. Newberry, is a guarantee of thoroughness. Into the volume's hundred odd pages are packed the important events of three thousand years of Egypt's rise and fall. It aims at a scientific statement of proven facts, and it ignores theories and traditions. It will have a few enemies among the theorists, but it will make more friends—for itself and for historic Egypt.

NOTES.

ASTRONOMICAL.

Herr Nippoldt on the Connection between Solar Activity and Terrestrial Magnetism.

In the October number of the [illegible], Herr A. Nippoldt, of the Potsdam Magnetic Observatory, criticised a recent paper by Father Cortie on "The Solar Prominences and Terrestrial Magnetism." The latter had endeavoured to show that the eclipse spot group of 1903, if it may so be called, by far the largest spot group of the year, had no effect upon terrestrial magnetism. Herr Nippoldt claims that a small but evident disturbance did take place during the passage of the spot. He is also emphatic that we have no right to assume that no disturbance has taken place unless magnetic stations near the pole have exhibited no deviations from their normal curve. He insists that there should be no kind of statistical definition of the idea of disturbance, that the maximum amplitude can hardly be usable to decide whether or not a curve is disturbed, and that we may represent the nature of the effect of the solar action upon terrestrial magnetism as a sort of relay action—"the strength of the releasing solar activity need not have a definite relation to the strength of the magnetic storm." He therefore desires to substitute for the statistical method the investigation in detail, and calls for a continued and uninterrupted registration of the changes occurring on the sun.

The paper is most disappointingly vague and inconclusive. The small disturbance of which he gives a trace can hardly be said to have been "simultaneous" with the spot, except in a very loose sense of the term, whilst it is only by a searching application of the statistical method that we can hope to discriminate between synchronisms which are purely accidental, and those which may be legitimately taken as establishing connection.

* * *

Demonstration of the Solar Origin of Magnetic Disturbances.

Quite a different method of treating this question was adopted by Mr. E. W. Maunder in a paper read before the Royal Astronomical Society on November 11. Tabulating all the magnetic disturbances of 20′ in declination and over, recorded at Greenwich Observatory from 1882-1903, and computing the heliographic longitude of the centre of the sun's disc for the time of commencement of each disturbance, it became clear at once that many of these disturbances recurred when the same solar meridian returned to the centre of the disc. In fact more than three-fourths of the total number catalogued (276) were included in some one of these series. There is only one conclusion, it was urged by Mr. Maunder, to be drawn from this relation, namely that the exciting cause of our magnetic disturbances was associated with definite limited areas on the sun. Further the magnetic action, whatever its nature, did not radiate equally in all directions, like light and heat, but acted along very definite and restricted lines. The mean rotation period indicated for these areas was the same as that given in the mean by the sun-spots; the extreme periods were those given by what we may fairly call the extreme sun-spots, that is to say those on the equator and in latitude 30°. Mr. Maunder found an analogy to these magnetic stream lines in the long rays of the corona, as photographed in the 1898 total solar eclipse. The solar action being of this nature, it is perfectly clear that the stream lines from many spots may miss our earth altogether, and hence a great spot need not necessarily be accompanied by a magnetic storm. On the other hand some of the disturbances recurred rotation after rotation when the spots with which they synchronised at their commencement had ceased to be visible. The paper therefore not only establishes an entirely new conception of the solar action in producing our magnetic disturbances, but suggests that there are definite active areas on the sun, intermittent in their activity, of which activity spot formation is an important phase.

* * *

The Spectra of R Scuti and W Cygni.

Mr. Ralph H. Curtiss has succeeded in photographing the spectra of both of these stars, and found the hydrogen lines bright at maximum. *R Scuti* gave a spectrum resembling the solar type; *W Cygni* a banded spectrum, with the bands sharp towards the violet and shaded off towards the red.

* * *

Rotation Periods of Venus and Mars.

In the "Comptes Rendus" of the Paris Academy, Mr. Lowell gives the result of a series of spectrographic determinations of the rotation of these two planets. For Venus, the speed of motion of a point on the equator was found to be practically nil, the probable error of the observation only amounting to 0·008 kilometres per second, the result thus supporting the idea that Venus rotates in the same period as her revolution. For Mars the speed was found as 0·228, the computed value being 0·241. The probable error in the case of Mars was 0·036. The satisfactory result obtained for Mars lends support to that for the larger and brighter planet.

We deeply regret to record the death of Mr. Frank McClean, M.A., LL.D., F.R.S., M.Inst.C.E. Mr. McClean was distinguished for his important spectroscopic researches and his liberal donations to further the cause of astronomy. His spectroscopic work included an elaborate series of comparative photographs of the high and low sun, a fine atlas in which he studied the comparative photographic spectra of the sun and the metals, and a great spectroscopic survey of all the brighter stars in the heavens. In order to render this work complete, Mr. McClean visited the Cape Observatory in 1897, where for six months he carried on his survey of the southern heavens. In the course of this work, he was able to identify between 40 and 50 of the lines of oxygen in the spectrum of Beta Crucis. His benefactions to astronomy include his foundation of the Isaac Newton Studentships at Cambridge, and the magnificent photographic telescope with its fine spectroscopic equipment which he presented to the Cape Observatory. Mr. McClean died at Brussels on the morning of November 8 in his sixty-seventh year.

We heartily congratulate the Astronomer Royal, Sir W. H. M. Christie, F.R.S., on his promotion to the rank of Knight Commander of the Order of the Bath (K.C.B. Civil Division).

* * *

Encke's Comet.

Encke's Comet has been not only photographed, but has also been seen and observed by Professor M. Wolf at the Astrophysical Observatory, Königstuhl, Heidelberg, on October 29. It has also been observed by Professor E. Millosevich, at the Observatory of the Roman College, in Rome, on October 30, and by Professor E. Hartwig, at the Bamberg Observatory, on October 31. The Comet is much fainter than was anticipated, and it is feared will never be bright enough to be seen with the naked eye.

* * *

The Parallax of Alpha Centauri.

At the station in the southern hemisphere of the Lick Observatory, located at Santiago de Chile, observations have been made during the past year of Alpha Centauri, and an average difference between the radial velocities of the two components is found of about 5·17 km. This may perhaps be due to the relative orbital motion of the two components, and, if so, it would indicate a parallax of 0·76, a combined mass of the components of 1·9 that of the sun; and a mean distance between the two components of 3·46 × 10^9 km. The parallax thus indicated is almost precisely that resulting from heliometer observations.

Intermittent Disturbances on Jupiter.

In the *Observatory* for October, Mr. Denny arrives at the very significant conclusion that "features exhibiting various peculiarities of appearance and rates of motion are common to certain latitudes and break out from time to time, enduring for certain unknown intervals, then disappearing to be replaced by similar phenomena." In his recent paper to the Royal Astronomical Society, Mr. Maunder draws attention to a somewhat similar intermittent action in the magnetic disturbances observed on the earth which are associated with certain solar longitudes.

BOTANICAL.

By S. A. Skan.

The exhibition of an extraordinary grass fruit at a meeting of the Linnean Society was noted in the columns of "Knowledge" nearly three years ago. A full account of its remarkable structure, written by Dr. Otto Stapf, is now published in the last part of the Society's Transactions. The fruit is the product of *Melocanna bambusoides*, which belongs to the tribe Bambuseæ of the grass family. It is an arborescent plant, growing to a height of from fifty to seventy feet, and is a native of Eastern Bengal and Burma. Unlike the ordinary fruit of the Gramineæ, which is small, often almost minute, and albuminous, that of *Melocanna* is sometimes as much as five inches long and two inches thick, globose or ovoid in shape, and exalbuminous. It is also remarkable in being viviparous, germinating before it falls from the parent plant, but this does not appear to be a constant character. Its pericarp, instead of the thin, membranous or crustaceous body of the usual grass fruit, serving practically only a mechanical function, is very largely developed and is fleshy, and serves partly as a reservoir for food material, a function which is shared by the scutellum, though this body retains its original character as a haustorium. Some albumen, or more correctly, endosperm, is formed in *Melocanna*, but Dr. Stapf shows that at an early stage it collapses "and is finally crushed into an apparently structureless film, wedged in between pericarp and scutellum."

* * *

The latest part of the "Annals of the Royal Botanic Garden, Calcutta," contains an elaborate monograph of the species of *Dalbergia* of South Eastern Asia, by Major D. Prain. *Dalbergia* is a large genus of Leguminosæ (Papilionaceæ), chiefly inhabiting the warmer parts of Asia. Its species are trees or climbing shrubs insignificant in their flowers, but several are important economically on account of their wood. *Dalbergia latifolia* is the Indian Blackwood or Rosewood, valuable for furniture. The Sissoo (*D. Sissoo*) supplies a timber remarkable for its strength and elasticity. Like the excellent monographs of *Quercus*, *Ficus*, and other genera which have appeared in the "Annals," Major Prain's work is accompanied by numerous illustrations.

* * *

Wiesner, Bonnier, Warming, Schimper, and other botanists have published observations on the influence of either humidity, heat, or light on plant structures. Monsieur J. [illegible], in a series of papers appearing in the current volume of the *Revue Générale de Botanique*, shows the combined influence of these agencies on the growth in a greenhouse of several of the common plants which are found growing wild in the neighbourhood of Paris. Specimens of such plants as the Daisy, Dandelion, Shepherd's Purse, Plantain (three species), and Milfoil were [illegible], some of each species being grown in the open air and others in a greenhouse. The experiments were carried on between the months of November and May. During this period, especially, the conditions of heat, light, and moisture in the greenhouse would be very different from those prevailing outside. The heat would be greater and more equable, the light more diffused, and there would be more moisture in the atmosphere. The influence of cultivation in the greenhouse on plants which normally produce a rosette of leaves adpressed to the soil was shown in a pronounced elongation of the internodes whereby the rosette arrangement disappeared, the leaves tended to become erect, and a marked increase in size was noticed. The internal structure of the roots, stems, and leaves of each set of specimens has been carefully examined and compared. In general the plants grown in the greenhouse have less differentiated tissues, less wood is formed, cell-walls are thinner, and intercellular spaces larger.

ORNITHOLOGICAL.

By W. P. Pycraft.

A Nestling Touracou.

At the last meeting of the British Ornithologists' Club, Mr. D. Seth-Smith exhibited the only known nestling of a Touracou. This was of the species known as Fraser's Touracou (*Turacus macrorhynchus*). The unique character of this exhibit was still further increased by the fact that the bird had been hatched in confinement in the aviaries of Mrs. Johnstone, at Bury St. Edmunds.

Mrs. Johnstone is the possessor of a pair of these birds, which, after a preliminary but abortive attempt at nesting in June last, succeeded, towards the end of July, in hatching two eggs, laid in a nest of sticks placed on a hamper-lid in a rhododendron bush.

Only one egg seems to have hatched out, and the nestling therefrom lived for four weeks, when it was killed by the cold nights of September.

Hitherto nothing was known of the condition of the young Touracou at birth. It was supposed that it would prove to resemble the young of the cuckoo; but this is not the case, inasmuch as the young cuckoo remains quite naked till the feathers appear, while the young Touracou is sparsely clad with down feathers, and bears a rather close resemblance to the remarkable and aberrant Hoatzin.

The wings of this nestling were, at the time of death, of great size, while the rest of the body remained still invested in its downy coat. Save that it was seen to clamber about the nest occasionally during the day, nothing was learned concerning it during life; but it is probable that the habits of the nestlings will turn out to resemble those of the Hoatzin described in our last issue.

* * *

Short-Eared Owl Nesting in Hampshire.

Mr. Trevor-Battye, in the *Avicultural Magazine* for November, records the breeding of a pair of Short-Eared Owls (*Asio accipitrinus*) on Bransbury Common, where a pair of young birds were successfully reared. This appears to be the first known instance of the nesting of these birds in this country.

* * *

Robins Catching Fish.

The *Field*, October 15, contains an interesting account of a party of five robins which were discovered hunting about among the pebbles in the bed of a small stream, from which they constantly flew on to a neighbouring wall, carrying some live object in their beaks. On a visit to the spot being made, a stickleback kicking vigorously was found. The observer (who signs himself "W. H.") then retired for about ten yards and watched their proceedings. The fish was taken from the water crosswise, and borne from the water to the wall to be dispatched. There seems to have been no attempt made to kill the prey before eating, as is done by the kingfisher; but then the fish was not swallowed alive.

* * *

A White Snipe.

A very beautiful white variety of the Common Snipe (*Gallinago caelestis*) has just been received at the Natural History Museum, South Kensington. This bird was killed at Poltalloch, Argyllshire. The only normally-coloured feathers were a patch on each side of the head, meeting one another at the crown; a few scapulars, the tail and under tail-coverts, a few under wing coverts, and three primaries in the left wing.

Sheep's Wool and Birds' Legs.

At the first meeting of the winter session of the Ornithologists' Club, Mr. Ticehurst exhibited a series of legs of the lapwing taken from birds shot on Romney Marsh during August last. These were very remarkable, inasmuch as they showed various stages of necrosis of the lower part of the leg, caused by the sheep's wool having become wound round the part affected.

In one of these legs the wool had been successfully removed by the bird and only a scar was left. In another the wool had so tightly encircled the toes that a partial necrosis of one member had taken place. In a fourth specimen this ligament had wound itself around tarso-metatarsus just above the toes, and in consequence these had all been lost.

A yellow wagtail with feet similarly affected was also shown. It is worthy of note that we have no records of starlings being affected in this way.

* * *

Spotted Crake in Antrim.

A Spotted Crake, records the *Field*, October 22, was shot near Templepatrick, Co. Antrim, on October 8. This makes the sixth occurrence of this bird in Antrim.

* * *

Solitary Sandpiper at Rye.

Mr. C. B. Ticehurst exhibited at the October meeting of the Ornithologists' Club a Solitary Sandpiper (*Totanus solitarius*) shot at Rye Harbour, Sussex, on August 7. This is the fourth British example of this American species.

* * *

Tawny Pipit at Rye.

At the meeting of the Ornithologists' Club just referred to Mr. C. B. Nicoll reported that three specimens of the Tawny Pipit (*Anthus campestris*) had been taken at Rye Harbour during August last. He himself shot an immature bird of this species on the sea-banks of Sussex near Bexhill. From the numerous occurrences of these birds he expressed his opinion that the Tawny Pipit was a regular autumn visitor on migration.

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Lapland Bunting near Pevensey.

Mr. C. B. Nicoll also reported that he had procured an immature example of the Lapland Bunting (*Calcarius lapponicus*) near Pevensey on September 28.

* * *

Broad-Billed Sandpiper at Rye.

Now that closer attention is being paid to birds on migration in the neighbourhood of Rye a number of rarities are being discovered. Mr. Nicoll, in addition to the records just described, also reported the occurrence of an immature Broad-Billed Sandpiper (*Limicola platyrhyncha*), which had been shot at Rye, Sussex. This is the fifth record of the occurrence of this bird in Sussex.

ZOOLOGICAL.

By R. Lydekker.

Quaggas and Wild Asses.

The present year has been noteworthy from the amount of literature devoted to the members of the horse tribe, or *Equidæ*. One of the latest contributions to the subject is an article by Mr. R. I. Pocock, the Superintendent of the London Zoological Gardens, on South African quaggas, published in the November number of the *Annals and Magazine of Natural History*. According to the author, we have to deplore the extermination not of one, but of several distinct forms of these animals; the quaggas of the older writers, of which two races are recognized, being distinct from those exhibited forty years ago in the Regent's Park and other menageries. Without for a moment saying that the author may not be right in his view, it certainly does seem strange that the whole of the quagga-skins which have come down to us should differ from the animals described by the older zoologists. The Asiatic and African wild asses form the subject of a paper by the present writer published in a recent issue of *Novitates Zoologicæ*, the organ of Mr. Walter Rothschild's zoological museum at Tring; an apparently new race of the "onager" from Central Asia, now living in the Duke of Bedford's park at Woburn, being described and figured. The description of one of the two races of the African wild ass is based on specimens killed in the Eastern Sudan by Mr. N. C. Rothschild, one of which is now mounted in the British (Natural History) Museum, while there is a second in the Edinburgh Museum, and a third in Mr. Rothschild's own collection. As the construction of the Suakin Berber railway is only too likely to lead to the extermination of this race, these specimens are very precious.

* * *

The Ancestry of the Horse.

In connection with articles on this subject, which have appeared during the year in "Knowledge" our readers may be referred to one by Professor H. F. Osborn on the evolution of the horse in America, published in the November number of the *Century Magazine*. The author is of opinion that the modern type of horse (that is to say, the genus *Equus*) was evolved in North America, whence it migrated by way of Bering Strait into Asia, and so into Europe and Africa. He is also inclined to look favourably on the theory that the blood-horse has a different ancestry to the ordinary breeds of Europe.

* * *

A White Racoon Dog.

For many years naturalists have been familiar with a remarkable Japanese and Chinese animal which, although externally somewhat like an American racoon, yet is really an aberrant member of the dog-tribe. Those who attach importance to external characters, rank the creature as the representative of a genus by itself, under the names of *Nyctereutes procyonoides*; while those who consider that generic distinctions should rest on important structural differences class it with the more typical dogs, as *Canis procyonoides*. The New York Zoological Park possesses at the present time a pure white racoon-dog, stated to have been brought from Northern Japan, which is regarded as representing a second species, for which the name *Nyctereutes albus* has been proposed.

* * *

A New Snake-Salamander.

The description (in the *Annals and Magazine of Natural History* for October) of a new species of those strange worm-like burrowing amphibians generally known as cæcilians, but which may be better designated in popular zoology as snake-salamanders, would scarcely seem at first a subject for notice in this column; but, as a matter of fact, this particular case has a very wide and important interest. The species in question, which comes from the Kachar district of Assam, is described by Major Alcock under the name of *Herpele fulleri*; and it is in regard to the peculiar geographical distribution of the genus that the interest of the new discovery lies. With the addition of the new species, the genus *Herpele* is represented in India, Panama, and West Africa; and, as Major Alcock remarks, such a distribution, in the case of a worm-like burrowing group appears altogether inexplicable on the theory that continents and ocean-basins are permanent, or, indeed, anything like permanent. On the other hand, the distribution of *Herpele*, together with that of certain sub-littoral hermit-crabs, which is curiously similar, affords strong support to the now generally accepted view that India and Africa were connected by land at a comparatively recent epoch of the earth's history (that is to say, within the lifetime of an existing highly specialised genus). The two instances also add one more link to the chain of zoological evidence which apparently points to a former land connection between Africa and South America across the Atlantic. The Indo-African connection, which is supported by geological as well as by zoological evidence, would explain the presence of cæcilians in the Seychelles as well as the absence of the above-mentioned littoral hermit-crabs from the east coast of Africa. The alternative view to the trans-Atlantic connection between West Africa and America (apart from one by way of the Pacific)

would be that these snake-salamanders travelled from a common northern home down the Eastern and Western Hemispheres. But this seems almost incredible.

* * *

The Animals of Africa.

The recent discoveries of wonderful new types of extinct animals in the tertiary deposits of the Fayum Desert of North-Eastern Africa, and their bearing on the origin of the modern African fauna, are discussed by the present writer in the October number of the *Quarterly Review*, in an article with the above heading. The new evidence shows unmistakably that the Proboscidea (elephants and mastodons) and the Hyracoidea (the "coney" of Scripture and its relatives) were developed in Africa itself; but it does not appear to invalidate the long accepted theory that the bulk of the modern African fauna is of northern origin. It might, however, have been added that, in view of the discovery of certain antelope and other remains in the later tertiaries of Africa, the migration may have been somewhat earlier than commonly believed. Probably, indeed, there have been several migrations of African types to the north, and of European and Asiatic types into Africa.

In this connection it may be mentioned that Dr. C. W. Andrews, the chief describer of the extinct Fayum fauna, has brought to notice in the November number of the *Geological Magazine* a remarkably fine shell of the giant land-tortoise, *Testudo ammon*, of the Upper Eocene beds of the district in question. This appears to be the earliest of the big land-tortoises, and may have been the ancestral type from which those of Madagascar, Mauritius, and the Mascarene Islands, together with the extinct Indian species, were derived.

* * *

An Intelligent Chimpanzee.

Berlin possesses a successor to the late lamented chimpanzee "Consul" in the shape of Consul II., of which the following account has been published. Recently Consul II. appeared before a meeting of the German Psychological Society, and was the subject of a lecture by the eminent psychologist, Professor Hirschlaff. The ape stood on the platform beside the lecturer in a smoking jacket, top-hat, black trousers, boots, and shirt. Professor Hirschlaff gave Consul an excellent character. He has good manners, is of a friendly disposition, and manifests symptoms of what would be called in human beings a loving nature. He has no objection to the vicinity of dogs, cats, or snakes, but is afraid of horses. No traces are seen in Consul of any special liking for women and soldiers. Like most apes he delights in children, but evinces an abhorrence of dolls, of which he can make nothing, and retires vanquished from their presence. If Consul is tickled he sometimes shrieks with laughter. When punished he acts like a child, holding his hands before his face. If discovered at anything he is forbidden to do he assumes hypocritically an innocent demeanour, which is distinctly human. He is restless, and cannot sit long in one position. With an excellent memory, he is yet incapable of expressing his wants either by gestures or sounds. He cannot be taught to whistle, nor does he understand human speech. All he can comprehend is the tone of a voice or the rhythm of words; and he cannot be taught to reckon. Although Professor Hirschlaff said that the psychological abilities of Consul are separated from those of human beings by a wide gulf, it is interesting to note how many complicated actions he can comprehend with the intellectual powers he possesses.

* * *

Papers read.

At the first meeting for the session 1904-5 of the Geological Society, held on November 9, the Rev. Osmund Fisher read a paper on the remains of the extinct southern elephant (*Elephas Meridionalis*) found in a cleft in the chalk at Dewlish, Dorsetshire. It was suggested that the cleft was the work of man, and was made for the purpose of entrapping the elephants, which fell into it. At the first meeting of the Linnean Society, held on November 3, Professor Herdman described certain features in the gills of the Ceylon pearl-oyster. Mr. A. W. Waters described some Bryozoa from Cape Colony, several of which he regarded as indicating new species. At the meeting of the Royal Microscopical Society on October 19, Mr. W. Colver directed attention to a peculiar laminated structure at the tip of the antenna of the common flea, which it was suggested might be an organ of smell. The following papers were read at the meeting of the Zoological Society on November 15:—On Mammals from Fernando Po, and on *Hylochoerus*, the Forest-Pig of Central Africa, by Mr. O. Thomas; on the Species of Crowned Cranes, by Dr. P. C. Mitchell; and on the Mouse-Hares of the genus *Ochotona*, by Mr. J. L. Bonhote. The alleged occurrence of Père David's deer (*Elaphurus davidianus*) in the island of Hainan was discussed at the same meeting by Mr. Lydekker; and various specimens were exhibited.

* * *

A New Wild Sheep.

Sportsmen will be interested in the description by Dr. J. A. Allen of an apparently new species of wild sheep from North-Western Kamchatka, belonging to the Algali group, as typified by the magnificent *Ovis ammon* of the Altai. The only wild sheep previously known from Kamchatka was *O. canadensis nivicola*, a near relative of the northern races of the American bighorn. Dr. Allen, whose article appears in the *Bulletin* of the U.S. National Museum, proposes to call the new sheep *O. storcki*, in honour of the collector of the type skull.

* * *

The Nature of Grouse Disease.

Among some of those qualified to form a trustworthy opinion the view seems to be gradually gaining ground that grouse disease is due to the presence of parasites (Sporatozoa) in the blood, and that, as in the case of malaria, the germs of these parasites are introduced into the blood by the bites of insects, the carriers in this instance being apparently midges, which at certain seasons absolutely swarm on the moors. On the other hand, in a fashionable weekly contemporary, a sportsman expresses his dissent from the view that the infection is carried by means of the midge. He may be pardoned for urging that the disease sometimes makes its appearance at seasons when midges are scarce; but when he proceeds to state that "if the midge by biting the grouse, a thing which has yet to be proved, infects him with virus so deadly, it is strange that men and deer, whom he certainly does bite, suffer nothing more than temporary irritation," he displays ignorance of some of the first principles of the subject. It may be added that there are still people who refuse to believe that malaria is propagated by means of mosquitoes.

* * *

Two More Extinct Animals.

A writer in the *Field* points out that two animals have comparatively recently become extinct without attracting notice on the part of naturalists. The one is the great straight-horned race of the Indian buffalo (*Bos bubalis macroceros*), which used to be met with, although rarely, in the Assam jungles as late as the "forties." The second is the wolf of the Falkland Islands (*Canis antarcticus*), an interesting but perhaps introduced species which appears to have been exterminated by strychnine during the "seventies."

* * *

Jerboas and Birds.

A curious structural resemblance has recently been pointed out as existing between the skeleton of the hind-leg of that pretty little Egyptian hopping rodent the jerboa and the same part in birds. In both the mammal and the bird the lower part of the leg is formed by a long, slender cannon-bone, or metatarsus, terminating inferiorly in triple condyles for the three long and sharply-clawed toes, the resemblance being increased by the fact that in both cases the small bone of the leg (fibula) is fused with the large one (tibia). It is further pointed out that in mammals and birds which hop on two legs, such as jerboas, kangaroos, thrushes and finches, the proportionate length of the thigh-bone or femur to the tibia and foot (metatarsus and toes) is constant, being 2 to 5; in animals, on the other hand, such as hares, horses, and frogs, which use all four feet the corresponding lengths are 4 to 7. It will, of course, be obvious that the resemblance between the jerboa's and the bird's skeleton is entirely owing to adaptation to a similar mode of existence. An interesting point in connection with the jerboa is that in the young the proportion of the femur to the rest of the leg is the same as in ordinary running animals.

Further, at an early stage of development the fibula is a complete and separate bone, while the three metatarsals which subsequently fuse together to form the cannon bone are likewise separate.

Were Our Ancestors Negroes?

An extremely interesting point with regard to the ancestry of the European or Caucasian races of mankind has been recently raised by certain discoveries on the Continent. It appears that the Anthropological Society of Paris has recently received two ancient skulls, the one from the dolmen of Pointe-de-Conquet, and the other from a tumulus in Brittany, both of which are distinctly of the negro type. Again, two other skulls of a similar type have been discovered in the cave of Baoussé-Roussé, near Mentone; while two more are recorded from the valley of the Rhone, in Valais, which belong to a more modern age. All these exhibit the characteristic negro feature of projecting jaws (prognathism), although it is not stated whether this is accompanied by the large teeth distinctive of modern negroes.

This indicates that the prognathic type of skull made its appearance occasionally among our prehistoric ancestors, as it does indeed now and then among ourselves; whether, however, this is due to direct inheritance, or whether it is sporadic, there is no evidence to show. Neither can we pronounce with any degree of certainty whether our earliest ancestors were or were not negroes.

Royal Society.

Award of Medals.

SUBJOINED is a list of this year's recipients of the medals in the gift of the Royal Society, the presentation of which took place at the anniversary meeting on St. Andrew's Day, November 30:—The Copley gold medal to Sir William Crookes for his experimental researches in chemistry and physics; the Rumford gold medal to Prof. Ernest Rutherford for his investigations into the properties of radio-active matter; Royal gold medals to Prof. William Burnside and Col. David Bruce, respectively, for mathematical researches and for researches into the causation of various tropical and other diseases; the "Sir Humphry Davy" gold medal to Prof. W. H. Perkin, jun., for his work in synthetic organic chemistry; the Darwin silver medal to Mr. William Bateson for investigations in heredity and variation; the "David Henry Hughes" gold medal to Sir Joseph Wilson Swan for his practical applications of electricity; the Sylvester bronze medal to Prof. Georg Cantor, of Halle, for researches in pure mathematics.

Copley.—The name of Sir William Crookes is one of the most familiar amongst English scientific men; instinctively we associate him with the most fruitful chapters in the record of physical science of the past half-century. In his hands spectrum analysis has yielded a rich harvest of results. Long ago, by its aid, he discovered the element thallium. Electrical science has been consistently advanced through his deductions and experimental skill, exemplified by a series of investigations, all the more sure because never hurried. Following the recognition of radium by the Curies, he became an ardent student of the problems surrounding its behaviour and properties. In this connection his researches (with Sir James Dewar) on the effect of extreme cold on the emanations of radium may be instanced. Mention, too, should be made of the invention of the ingenious Spinthariscope, which demonstrates to the eye those scintillations proceeding from radium nitrate which, in his own apt words, convey the appearance of a "turbulent luminous sea." Sir W. Crookes' medallic roll of honour comprises, in addition to the present award, the Royal medal (1875), and the Davy medal (1888).

Rumford.—Prof. Ernest Rutherford, whom, by the way, the Cambridge School of Physicists include in their ranks, since he was a pupil of Prof. J. J. Thomson, is one of the younger workers in the department referring to radio-active matter. His paper, "On a Radio-active Substance Emitted by Thorium Compounds," was an introductory of profound significance to those engaged in the higher realms of physical inquiry.

Royal.—Prof. W. Burnside is a voluminous writer on mathematical subjects, particularly on the Theory of Functions (Proceedings, Cambridge Philosophical Society), and the Theory of Groups. Col. David Bruce R.A.M.C., has rendered valuable service in that comparatively new field of inquiry which embraces the study of the causation of tropical diseases, in particular, "Malta" Fever, Tsetse Fly Disease, and Sleeping Sickness, a department of work in which pathology, medicine, and entomology have each a share as agents of discovery and prevention. Ten years ago he was patiently carrying out investigations in Zululand on the diseases "N'gana" and Tsetse Fly. He showed that in character they were identical; further, that the insect known as the tsetse fly was, in reality, the carrier of the parasitical organism (Trypanosome), whose presence entailed pathogenic consequences. This was a new observation, and it marked a long stride forward. As the outcome of researches conducted last year in Uganda, he supplied the proof (removed from conjecture) that Sleeping Sickness, or what is now called Trypanosomiasis, is induced by a microscopic parasite occurring in the blood of the human subject; moreover, that a species of the tsetse fly (*Glossina palpalis*) acts as the carrier of the organism.

Davy.—Prof. W. H. Perkin, jun., was formerly Lecturer and Research Assistant in the Dyeing Department, Yorkshire College, Leeds. He is the author of numerous papers on the colouring matters of plants, especially those of Indian origin. It is, however, for his long-continued and fruitful researches and discoveries in synthetic organic chemistry that he receives the medal.

Darwin.—Mr. W. Bateson's investigation of heredity and variation problems have attracted wide attention. He has redeemed from seclusion the labours of the naturalist Mendel, and directed a large body of workers to the important facts indicated by the studies of that observer.

Hughes.—Sir Joseph Wilson Swan's scientific labours have been concerned principally with the introduction of improvements in the applications of electricity and of the chemical arts in relation to photography. The adoption and development of electricity as a mode of lighting is intimately associated with his invention of the incandescent electric lamp. He was the first to use a filament of carbon. Originator of the autotype process, he has in other directions aided photography in the dual aspects of art and science.

Science at St. Louis.

An exhibition on such a very grand and hitherto unequalled scale might have been expected to have introduced some wonderful novelties to the sight-seeing public, but, as it so happens, no startling new inventions, or specially peculiar constructions, have been forthcoming to add to the attractions at the St. Louis Fair. While speaking of this as an exhibition on an unequalled scale, we may quote some figures as giving an interesting summary of the area under roof of shows of a similar nature.

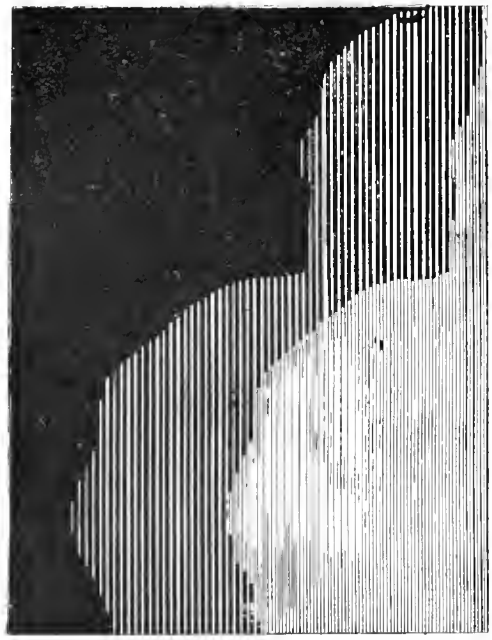
London, 1851	21 acres.
Paris, 1867	37 ,,
Philadelphia, 1876	65 ,,
Paris, 1889	75 ,,
Chicago, 1893	200 ,,
Paris, 1900	125 ,,
St. Louis, 1904	250 ,,

The total area of grounds occupied increased in an even larger ratio, the acreage at St. Louis amounting to some 1240 acres.

The excellent design of the buildings and laying out of the grounds, and the vast number of exhibits render this a truly notable exhibition, and it seems hardly likely that it will be exceeded in the near future. The immense cost is said to be far above the actual profits, which does not augur well for future rivals. Bad luck, or rather lack of good luck, has proved very detrimental to the undertaking, and, notwithstanding the offers of huge prizes for airships and other attractions, no exhibits of special novelty or interest have been acquired. To this statement there is perhaps one exception, and that is in the great solar-heat concentrator being erected by Prof. Himalaya. Yet this apparatus, which may not even prove to be as wonderful as the inventor anticipates, is, towards the end of October, not yet completed, and therefore has attracted but little attention from visitors. We shall hope to give a separate and full account of this later on.

On wandering through the vast buildings of Transportation, Electricity, Machinery, and Varied Arts, one eagerly looks for some new and interesting object or contrivance, but in vain. There are huge modern locomotives, interesting models of many old engines, motor cars of all kinds; there are enormous plants for generating electricity, turbine engines, and various methods of electric lighting. Among the latter are two forms still but little known to the English public, the Cowper-Hewitt and the Nernst. But these are hardly to be classed as scientific novelties, and, indeed, are not exhibited as such. The mercury vapour lamp, with its weird blue effects, is to be seen in each of the many photographers' studios, as well as among the illuminations of the grounds. With many exhibits there is a notable lack of proper labelling, and many an interesting object may be passed by unheeded on this account. For instance, the new Edison storage battery is, of course, well to the fore, but though there are a number of them exhibited there is no descriptive account to give particulars, which would, without doubt, be widely read.

Composite Picture of two Stereoscopic Views, each covering alternate stripes.



Portion of Picture (left hand top corner), enlarged to show system of stripes.

A conspicuous feature in the grounds is the tower forming the station of the De Forrest Wireless Telegraph. But we are now getting so accustomed to this form of communication that it excites but little more interest than would an ordinary telegraph office. In the Aëronautical sheds are two or three strange aërial leviathans, though experts seem agreed in not anticipating any very special advance in aerial navigation by their means. Besides various specimens of kites for meteorological work, shown by the Governments of both the United States and Germany, are the models of Prof. Langley's aëroplane machines and a model of the Deutsch airship.

In the Electricity Building are two different instalments of "Wireless Telephone" apparatus. One is the "Radiophone," by means of which sound is conveyed along a

powerful beam of light, and here is certainly an interesting exhibit, although the system has been before the scientific world for some years. From a practical point of view, the invention may seem disappointing, for at the transmitting end a man shut in a sound tight cupboard blows a loud bugle, the sound of which is conveyed by the searchlight to a distance of only 150 feet, when it is received on a silenium cell, and is very faintly audible in a telephone receiver. The other wireless telephone is on the Miller-Reece-Hutchison system, in which the transmitter is connected with a large coil of wire underground, and the receiving telephone with a coil held in the hand.

Elsewhere exhibits are given of the properties of liquid air and of thermit, extremes of cold and heat which may not be familiar to many visitors.

Of course, several methods of obtaining photographs in natural colours are to be found among the profusion of exhibits. Mr. Cowper Coles shows specimens of electrically deposited metals and the differences of surface obtained by rotating the cores at various high speeds while the coat is forming.

Diagram to show how one eye sees one series of stripes while the other sees only the other series.

The Delaney system of rapid automatic telegraphy is one of the interesting novelties shown. This is a perforated tape machine designed to overcome the tendency existing in other machines of this sort to blur the dots and dashes when sent over a long line. In the perforating apparatus the depression of the key causes a magnet to operate a punch near the upper edge of the tape, while the release of the key brings into operation a punch near the lower edge, so that as the tape is travelling forward the dots and dashes are distinguished by the angular distance of the holes. In the transmitting machine the upper holes give connection to a positive current, while the lower ones give a negative current; so that impulses are sent through the line which are not blurred by the static capacity of the cable. It is said that in laboratory experiments messages have been sent at the rate of 5000 words per minute, and even over lines 1000 miles long a speed of 1000 words a minute has been attained.

A fascinating instrument to watch is the Telautograph, for reproducing at a distance handwriting, sketches, and similar matter—in fact, a "writing telegraph." The transmitting and receiving instruments are so arranged that the pen on the latter moves synchronously with the transmitting pencil. The operation is as follows:

At the transmitter the sending pencil is attached by two light rods to two lever arms which carry contact rollers at their ends. These contact rollers bear against the surface of two current-carrying rheostats, and the writing currents pass from the rheostats to the rollers, and from them to the line wires.

When the pencil is moved, the position of the rollers upon the rheostats is changed, and currents of varying strength go out upon the line wires.

At the receiver these currents pass through two light vertically movable coils, which are suspended in uniform magnetic fields, and which move up or down against the pull of retractile springs, according to the strength of the line currents. The motion of the coils is communicated to a set of levers of the same length as those in the transmitter. At the junction of the levers is mounted the receiving pen, which by the motions of the coils is caused to duplicate the motions of the transmitting pencil.

The paper is supplied from rolls beneath the transmitter and receiver, and is shifted off the writing platens as it is used.

Another machine worth looking at is a Hydro-Pneumatic Rock Drill in operation, driving holes $1\frac{1}{2}$ inches in diameter through a lump of solid granite at a rate of nearly 6 inches a minute. This runs at a speed of about 1000 strokes a minute, the length of stroke being about an inch, and the tool being turned 1-11th of a revolution each stroke.

An interesting system of obtaining a stereoscopic effect by means of a lined screen is exhibited, and, as no description of the method seems to have been published before, it may be interesting to describe shortly the general principles involved. It is called the Parallax Stereogram. Two photographs are obtained by twin stereoscopic lenses in the usual way, except that a screen is interposed, formed of fine parallel lines at intervals equal to their thickness (100 to the inch). Each negative will then consist of a series of stripes. The negatives are then exactly superposed so that the stripe left blank on the one coincides with the stripe containing the picture on the other. The resulting image, presenting a most sorry effect, may be seen on opposite page. But if this picture be viewed at a certain distance off, with the screen suitably interposed, the right eye will only be able to see one picture, while the left will only be able to see the other. The result is that the subject appears to stand out in high relief.

Those who have a fondness for Nature in her quieter moods and a love for Natural History will find in "Notes of an East Coast Naturalist," by Arthur Patterson (Methuen) a very charming companion and guide. That the author writes with a first-hand knowledge of his subject is evident, both from the originality of his observations as well as from the spirit of enthusiasm which is manifest in every page. His glimpses of the bird life of the mud-flats, marshes, and sea-shore in the neighbourhood of Great Yarmouth are really delightful. We fully sympathise with the author's sentiment against shooting. Though at one time an enthusiastic gunner, he assures us that he had derived far more pleasure in studying the bird-life of this district by the aid of field glasses. The short sketches concerning the fish fauna of his neighbourhood are teeming with interest, and contain some shrewd observations well worthy of careful consideration. As much also may be said for his notes on the crustacea of the district. Space forbids a larger notice of this book, but we most heartily recommend it. The coloured illustrations are in many cases extremely good. But for the artist's name on the plates, we should have attributed many of the figures of the birds to G. E. Lodge and A. Thorburn.

The Administration of Chloroform.

The arrangements for the entertainment of the French doctors last month included a visit to the fine research laboratories that have recently been installed at the headquarters of the University of London, in the building which the University now shares with the Imperial Institute, in South Kensington.

The French visitors were conducted through the various departments of the laboratory by the Director, Dr. Waller, and showed much interest in the work at present going on in electro-physiology, which is made a special feature there. Dr. Waller subsequently demonstrated the graduated administration of chloroform as an anæsthetic.

Since the institution of a Special Committee in 1901 by the British Medical Association to inquire into the administration of chloroform, and cause of the dangers too frequently attending it, various forms of apparatus have been brought forward for the graduated dosage of chloroform. The importance of the subject must infallibly be recognised in view of the too-frequent deaths occurring from chloroform anæsthesia, and of the painful nausea that so often results from its administration. Nor again, is it sufficient that the apparatus shall be "capable of delivering graduated amounts of chloroform under laboratory conditions; that method or apparatus is the safest by which under clinical conditions, and in spite of the unavoidable irregularities due to the anæsthetist or the anæsthetised, greatest uniformity and regularity of chloroform intake shall be maintained." . . . The two forms of apparatus that conform best with this requisition are the Dubois pump and Waller's wick vaporiser. The former delivers a known volume of chloroform and air, at percentages variable from 1–3 per cent. with gradual and regular induction of anæsthesia, which is easily controlled. This instrument, however, is complicated and expensive. The other and more portable form of evaporator is an ingenious adaptation of the wick carburettor used in certain kinds of motor cars. In overhauling and dissecting a Daimler car, it occurred to Dr. Waller that "if by evaporation from wicks, enough petrol vapour can be got to drive a heavy car at high speed, it should be an easy matter to find a wick surface capable of supplying 1–2 per cent. of chloroform vapour to, say, 10 or 15 litres of air per minute, *i.e.*, in liberal excess of the volume of air normally breathed, which may be reckoned as 5–6 litres per minute. (The average volume of chloroform vapour required is 100–200 cc. per minute; a wick carburettor will afford something like 100 litres of petrol vapour per minute.)"[†]

The wick vaporiser has been tested clinically at St. George's Hospital, and the principle of dosage by delivery from wicks returning a known strength of chloroform vapour in air proved entirely successful. It should be added that in this and other similar apparatus the percentage delivered is verified by the method invented by Drs. Waller and Geets for *weighing* the $CHCl_3$ vapour.

For laboratory purposes also the wick vaporiser has approved itself. A demonstration of the action of choloroform on cats and rats, with both forms of inhaler, was given by Dr. Waller to the French doctors who visited the Physiological Laboratory of the University of London. The wick vaporiser delivers about 2 per cent. of $CHCl_3$ and air. The animals invariably go under quietly with no sign of distress or struggle, and recover perfectly, even after prolonged anæsthesia. The treatment may be repeated day after day with no injurious effects, and it is even reported in the laboratory that one kitten contracted the chloroform habit, and pleaded for its daily anæsthetic.

The anæsthesia of small animals up to 10 or 12 kilos in weight is induced in a 15 or 30 litre jar, into which air is pumped through the vaporiser by foot bellows. The anæsthesia is subsequently maintained through the tracheal tube connected with the vaporiser. The depth of anæsthesia is under complete control, the strength of mixture being raised or lowered as required by raising or lowering the wicks of the vaporiser.

FRANCIS A. WELBY.

* A. D. Waller, "Examination of Apparatus proposed for the Quantitative Administration of Chloroform." *Lancet*, July 9, 1904.

† A. D. Waller, Proc. Physiol. Soc., Aug. 10, 1904. Vol. xxxi. *Journal of Physiology.*

Chimpanzis and Gorillas.

By R. LYDEKKER.

The recent arrival and lamented deaths of the two young gorillas at the Zoological Society's menagerie in the Regent's Park have given rise to a considerable amount of popular interest in these great tropical African apes and their near relatives, the chimpanzis. Accordingly, it is a fit opportunity to devote an article in "KNOWLEDGE AND SCIENTIFIC NEWS" to the consideration of some of the leading characteristics of these two species and their relationship to one another. In referring to these animals as being represented by two species only, I am quite aware that I am going against the views of several of my brother naturalists, who are of opinion that there are several species both of gorillas and chimpanzees. My own opinion, on the other hand (and it cannot be too strongly emphasized that what does or does not constitute a species is merely a matter of opinion, and is, moreover, a matter of little or no importance), is that these so-called species are really local races, or sub-species; and that there are only two distinct types of great African apes, the chimpanzi (*Anthropopithecus troglodytes*), and the gorilla (*Anthropopithecus gorilla*). Here again I fear that I shall be treading on the toes of some of my naturalist friends, who prefer to regard the larger of the two species as representing a genus by itself under the name of *Gorilla*; but from the fact that it is in some cases very difficult to decide whether a particular ape should be classed as a chimpanzi or a gorilla, it appears little short of an absurdity (even admitting that genera, like species, are merely expressions of individual, or it may be collective, opinion) to regard each as the type of a genus by itself. One other point in connection with preliminaries, and I have done. It will be observed that throughout this article the common name of the smaller of the two apes is spelt chimpanzi instead of the familiar chimpanzee. This has been done in order to be in uniformity with the spelling of names like Fiji and okapi, for it is manifest that if we spell such names with a final *i*, we should do the same in the case of chimpanzi and manati. It may be added that the two latter names, like okapi, should probably be pronounced with the accent on the second, instead of on the final, syllable.

Both the chimpanzi and the gorilla are ranked by naturalists among the man-like, or anthropoid, apes, and are the only living African representatives of that group which includes, however, the orang-utan of Sumatra and Borneo, and the gibbons of Assam and the Malay countries. The man-like apes, it may be observed, differ, among features, from baboons and monkeys, by the absence of a tail, of pouches in the cheek for storing food, and of callosities, or hard patches, on the buttocks, as well as by the circumstance that the breast-bone is flattened from back to front instead of from side to side, being, in fact, a depressed instead of a compressed bone, and thus better adapted to permit the free use of the arms in an upright posture. In all these respects, as well as in the structure of the cheek-teeth, which are quite unlike those of monkeys and baboons, the man-like apes resemble man himself; and of all the four existing generic types of the former, the chimpanzi and the

gorilla are the two which approximate most nearly to the human type, the chimpanzi being structurally the nearer of the two to man, although the gorilla marks a step in the direction of the latter by its much less completely arboreal habits. Both the African species are normally black or blackish in colour, and differ strikingly from the orang in that there is no marked and decided difference in the form of the face and head in the two sexes; the male merely showing in this respect an exaggeration of the structural features of the female. In this respect they again show a decided approximation to the human type. For a long period both species were believed to be confined to the tropical forests of the West Coast of the Dark Continent, but the chimpanzi was ascertained by Schweinfurth and Emin Pasha to range into the Niam-niam country and East-Central Africa, and quite recently the gorilla has been found to have a somewhat similar distribution, so that their habitat may be taken to include a large part of the equatorial forest belt. That the ancestor of the group was not, however, a native of Africa may be inferred with considerable probability from the fact that the jaws of a fossil chimpanzi have been discovered in the later Tertiary deposits of North-Eastern India; and it is not a little remarkable that in some particulars the teeth of this extinct Indian chimpanzi come nearer to those of man than do those of either of the two living African man-like apes.

Of the two species, the chimpanzi has been for much the longer time known to European science, Dr. Tyson, a celebrated surgeon and anatomist of his time, having dissected a young individual, and described it, as a pigmy, or *Homo sylvestris*, in a book published so long ago as the year 1699. Of this baby chimpanzi the skeleton is still preserved, and may be seen any day in one of the bays of the central hall of the Natural History Branch of the British Museum alongside the volume in which it is described. It was not, however, till nearly a century later (1788) that the chimpanzi received what is now recognised as a valid scientific name, having been christened in that year *Simia troglodytes* by the French naturalist Gmelin. In his classification it was included in the same genus as the orang-utan, but since such an arrangement scarcely coincides with modern ideas of systematic zoology, it is now generally known as *Anthropopithecus troglodytes*. Whether any stickler after priority will seek to revive Tyson's name, and call the creature *Anthropopithecus sylvestris*, remains to be seen. If he does so, and the change be adopted generally, the chimpanzi would have a much more appropriate designation than it has at present, the "man-like ape which dwells in the woods" being infinitely superior to the "man-like ape which dwells in caves," since the chimpanzi is an arboreal and not a spelaean animal.

As regards the history of the second and larger species, it was at one time supposed that the apes encountered on an island off the West Coast of Africa by Hanno, the Carthaginian, were gorillas, but in the opinion of those best qualified to judge, it is probable that the creatures in question were really baboons. The first real account of the gorilla appears to be one given by an English sailor, Andrew Battel, who spent some time in the wilds of West Africa during and about the year 1590; his account being preserved in Purchas's "Pilgrimages," published in the year 1748. From this it appears that Battel was familiar with both the chimpanzi and the gorilla, the former of which he terms engeco and the latter pongo—names which ought apparently to be adopted for these two species in place of those now universally in use. Between Battel's time and 1840 nothing appears to have been heard of the gorilla or pongo, but in that year a missionary at the Gabun accidentally discovered a skull of the huge ape; and in 1847 a sketch of that specimen, together with two others, came into the hands of Sir Richard Owen, by whom the name *Gorilla savagei* was proposed for the new ape in 1848. Unfortunately Dr. Savage, a missionary at the Gabun, who sent Owen information with regard to the original skull, himself proposed the name *Troglodytes gorilla* in 1847, and this specific name accordingly stands. The first complete skeleton of a gorilla sent to Europe was received at the Museum of the Royal College of Surgeons in 1851, and the first complete skin appears to have reached the British Museum in 1858.

Adult gorillas have never been seen alive in captivity—and probably never will be, as the creature is ferocious and morose to a degree. In addition to the two which made such an unfortunately brief sojourn in the Regent's Park during the present year, a few other immature examples have been brought alive to this country. Of these the following account is reproduced from the "Zoological Notes" column in a recent issue:—

"Only two have, however, been previously exhibited in the Regent's Park. The first of these was a young male, purchased in October, 1887, from Mr. Cross, the well-known Liverpool dealer in animals. At the time of arrival it was supposed to be about three years old, and stood 2½ feet in height. The second, which was a male, and considered to be rather older, was acquired in March, 1896, having been brought to Liverpool from French Congoland by one of the African Steamship Company's vessels. It is described as having been thoroughly healthy at the date of its arrival, and of an amiable and tractable disposition. Neither of these animals survived long."

So long ago as the year 1855, when the species was known to zoologists only by its skeleton, a gorilla was actually living in this country. This animal, a young female, came from French Congoland, and was kept for some months in Wombwell's travelling menagerie, where it was treated as a pet. On its death, the body was sent to the late Mr. Charles Waterton, of Walton Hall, by whom the skin was mounted in a grotesque manner, and the skeleton given to the Leeds Museum. Apparently, however, it was not till several years later that the skin was recognised by the late Mr. A. D. Bartlett as that of a gorilla; the animal having probably been regarded by its owner as a chimpanzi.

Chimpanzis, on the other hand, are comparatively common in captivity, although most are quite young, and only a few survive to anything approaching maturity.

Between a typical chimpanzi and a typical gorilla there is no difficulty at all in drawing a distinction; the difficulty comes in when we have to deal with the aberrant races (or species) of chimpanzi, some of which are so gorilla-like that it is somewhat hard to decide to which species they really pertain. The ordinary chimpanzi, especially in the young state, is such a familiar animal that a portrait is unnecessary. In height the adult male does not exceed five feet, and the colour of the hair is a full black, while the ears are remarkably large and prominent, and the hands reach only a short distance below the knees. The head is rounded and short, without prominent beetling ridges above the eyes, or a strong crest along the middle line of the back of the skull; while the tusks

of the old males are of no very great length and prominence. Gentleness and docility are specially characteristic of the species, even when full-grown; while in the native state its habits are thoroughly arboreal.

What a contrast between such a creature and an old male gorilla, one of the most savage and untamable beasts on earth, with the eyes overhung by a beetling penthouse of bone, the hinder half of the middle line of the skull with a wall-like bony ridge for the attachment of the powerful jaw-muscles, and the tusks of monstrous size, and recalling those of a carnivorous animal. These characteristic traits are well displayed in the accompanying photograph (Fig. 1) of the head and bust of a huge male gorilla shot by Mr. H. Paschen in the hinterland of the Cameruns, and now in Mr. Rothschild's Museum at Tring, which also exhibits the relatively small size of the ears and the elongated form of the head distinctive of the gorilla. Another characteristic of this species is the small size of the thumb and the length of the arm, the latter reaching to the middle of the shin-bone.

Fig. 1.—Bust of Male Gorilla from the Cameruns. (After H. Paschen.)

If we had only these two typical forms to deal with, there would be, as already said, no possibility of confounding a chimpanzi with a gorilla. When, however, we pass into Central Africa we find the chimpanzis assuming more or less marked gorilla-like traits which render the distinction in some cases a matter of difficulty. The first of these aberrant types is Schweinfurth's chimpanzi (*Anthropopithecus troglodytes schweinfurthi*), which inhabits the Niam-niam country, and, although evidently belonging to the same species as the typical race, exhibits certain gorilla-like features. These traits are still more developed in the bald chimpanzi (*A. t. tschego*), of Loango and the hinterland of the Gabun and French Congoland, which takes its English name from the sparse covering of hair on the head. The most gorilla-like of all the races is, however, the kulu-kamba chimpanzi (*A. t. kulu-kamba*) of du Chaillu, which inhabits Central Africa. The celebrated ape "Mafuka," which lived for some time in the Dresden Zoological Gardens during 1875, and came from Loango, was apparently a member of the bald race, although it was at one time regarded as a hybrid between a chimpanzi and a gorilla. The gorilla-like features in the head are well displayed in the accompanying photograph (Fig. 2), which was taken immediately after death.

These gorilla-like traits are still more pronounced in the subject of figure 3, which is taken from "Johanna," a female chimpanzi living in Barnum and Bailey's show in 1899; the figure being reproduced from one illustrating a paper on that animal by Dr. Keith. The heavy ridges over the brow, originally supposed to be distinctive of the gorilla, are particularly well marked in "Johanna," and they would doubtless be still more noticeable in the male of the same race, which seems to be undoubtedly du Chaillu's kulu-kamba. Still, the large size and prominence of the ears proclaim that

Fig. 2.—Head of Female Kulu-Kamba Chimpanzi "Mafuka." (From a photograph lent by Dr. H. B. Meyer.)

both "Mafuka" and "Johanna" were chimpanzis and not gorillas. A gorilla-like feature in "Johanna" is, however, the presence of large folds at the sides (ala) of the nostrils, which are absent in the typical

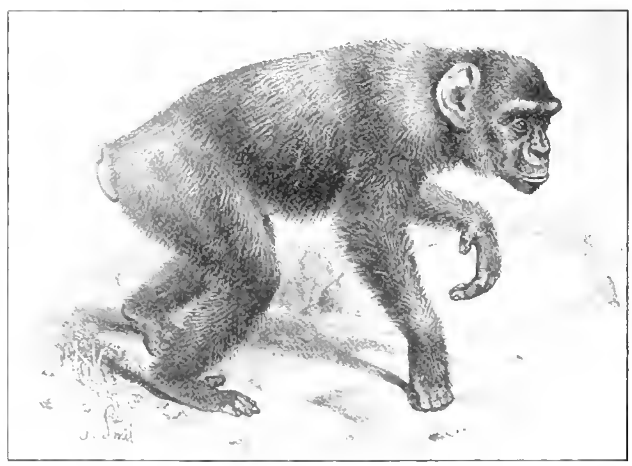


Fig. 3.—Female Kulu-Kamba Chimpanzi "Johanna." (From the plate in the Zoological Society's *Proceedings* illustrating Dr. Keith's Memoir.)

chimpanzi, but in the gorilla extend down to the upper lip.

Dr. Keith, who has paid special attention to the subject, is, indeed, of opinion that, in addition to its smaller and flatter ears, the gorilla may be best dis-

tinguished from the chimpanzi by the presence of this great nasal fold running to the margin of the upper lip, by the large size and peculiar characters of the tusks and cheek-teeth; by its broad, short, thick hands and feet, of which the fingers and toes are partially webbed; by the long heel; and by the relative length of the upper half of the arm as compared with the fore-arm. An important distinctive feature of the skull of the gorilla is the great length of the nasal bones. Finally, in life the gorilla is sharply differentiated from the chimpanzi by its sullen, untamable, ferocious disposition.

As regards the relationship existing between the gorilla and the chimpanzi, Dr. Keith's observations are so important and so interesting, that they may be quoted, with a few verbal alterations, at length:

"An examination of all the structural systems of the African anthropoids leads to the inference that the gorilla is the more primitive of the two forms, and approaches the common parent stock more nearly than does the chimpanzi. The teeth of the gorilla, individually and collectively, form a complete dentition, a dentition at the very highest point of development; the teeth of the chimpanzi show marked signs of retrogression in development both in size and structure. The muscular development and the consequent bony crests for muscular attachment of the gorilla far surpass those of the chimpanzi. The muscular development of the adult chimpanzi represents that of the adolescent gorilla. Some of the bodily organs of the gorilla belong to a simpler and earlier type than those of the chimpanzi. But in one point the chimpanzi evidently represents more nearly the parent form—its limbs and body are more adapted for arboreal locomotion; of the two, the gorilla shows the nearer approach to the human mode of locomotion. On the whole, the evidence at our disposal points to the conclusion that the chimpanzi is a derivative from the gorilla stock, in which, with a progressive brain-development, there have been retrograde changes in most of the other parts of the body. The various races of chimpanzi differ according to the degree to which these changes have been carried."

In conclusion it should be mentioned that four types of gorilla are now recognised by naturalists. Firstly, we have the true *Anthropopithecus gorilla typicus*, of the Gabun, in which the general colour is blackish grey, frequently with a mixture of reddish brown hair on the crown of the head; while very old males take on a whitish grey tinge on the upper portion of the thigh and the lower part of the back. Secondly, there is *A. g. castaneiceps*, which apparently ranges southward to Portuguese West Africa, and has longer hair, with the crown ochre-brown, the back grey, and the limbs blackish. The third form is *A. g. beringeri*, founded on the skull of a male killed near Mount Kirunga, south of the Albert Edward Nyanza, in which the males are bearded. Finally, *A. g. diehli* is known only by a skull from the Cameruns.

"Physiography" (Macmillan and Co.), by T. H. Huxley. This excellent standard work on the introduction to the Study of Nature has been revised, extended, and to some extent re-written by Professor R. A. Gregory, of Queen's College, London. He has done his work with modesty and discretion, and the addition of copious illustrations greatly add both to the usefulness and attractiveness of the book.

CORRESPONDENCE.

Snake Forms in the Constellations.

To the Editors of "Knowledge."

Gentlemen,—In your issue of October, 1904, Mr. Maunder writes as follows: "If we take a precessional globe, move the pole back some 64° or 65° of precession, corresponding, say, to about 2700 B.C., and adjust the globe for N. Lat. 40°—in other words, set it to the time and place when the constellation figures were first defined—what do we find? First of all the Great Dragon . . .

"Next Hydra. Here we have an arrangement even more striking. As fig. 3 will show, Hydra at this time lay right along the equator, extending over about 105°, or seven hours of Right Ascension. Thirdly, Serpens . . . It is scarcely conceivable that this threefold arrangement, which is not suggested by any natural grouping of the stars, should have been carried out as a matter of pure accident. It must have been intentional. For some reason or other—possibly for the simple one that a snake was the animal form that best lent itself to such a purpose—the equator, the colure, the zenith and the poles were all marked out by these serpentine or draconic forms."

Will you allow me space in your columns to re-state an alternative suggestion made by me, concerning the date of the first imagining of the constellation Hydra, in a paper entitled, "Astronomy in the Rig Veda," read in Rome, October, 1899, at the Oriental Congress, and reprinted in my book, "Ancient Calendars and Constellations."

This suggestion would credit the astronomers of old with a recognition of the deeper meanings of an almost universal serpent symbolism; and it is, as it appears to me, more in line with the results of recent archæological discoveries which seem almost necessarily to throw back such symbolism, and with it the dawn of astronomy, to a date much earlier than 2700 B.C.

"On the celestial sphere many serpents and dragons are represented, but the far-reaching constellation Hydra exceeds all the others in its enormous length from head to tail. No very brilliant stars mark the asterism, nor in the grouping of its stars is there anything especially snake-like. For some reason other than its appeal to the eye did astronomers of old invest with all the horrors of the Hydra-form the monotonous length of this space on the vault of the skies.

"This reason may be arrived at, with almost certainty, in studying, with the help of a precessional globe, the position in the heavens of this constellation in different ages of the world's history. So studying, we shall find that 4000 B.C.—or, to be more precise, one or two hundred years earlier—Hydra extended its enormous length for more than 90° symmetrically along one astronomically important (though invisible) mathematical line—the line of the heavenly equator—and was at the same date accurately bisected by another equally important mathematical line, namely the colure of the summer solstice.

"Almost irresistibly, as it appears to me, the conviction forces itself on the mind, in considering the position held by the constellation Hydra 4000 B.C., that it was at that date that this baleful figure was first traced in imagination on the sky, there fitly to represent the power of physical (and may we not suppose also, of moral?) darkness—a great and terrible power—but a power ever and ever again to be conquered by the victorious power of light. In astronomic myth this power was represented as that of the sun at the season of its highest culmination, the season of the summer solstice. For an observer in the temperate northern zone all through the long nights of mid winter, the whole length of the dreadful Hydra was at the date named visible above the horizon. The dark mid-winter season was therefore the time of the Hydra's greatest glory. At every season of the year, except at that of mid-summer, some portion of the monster's form was visible during some part of the night. But at the summer solstice no star in the constellation might show itself for ever so short a time."

I am, Gentlemen, &c.,

Emmeline M. Plunket.

The Oaks,
Wimbledon Common.

The credit belongs to Miss Plunket of having first pointed out that the Hydra was clearly designed by the original constellation makers to mark the equator celestial, and I have no doubt that Miss Plunket's suggested reason is quite correct, namely, that the ancients wished to mark by this great snake the part of the equator which was furthest below the track of the sun. And it lay along the equator approximately both at the date she urges (4000 B.C.) and at that which I put forward (2700 B.C.). Nevertheless the earlier date is inadmissible. The south pole of 4000 B.C. is too far from the centre of the unmapped space in the southern heavens for the work of constellation making to have been completed by that epoch; and, as I have elsewhere pointed out, the traditional figures bear too manifest indications of being items in a single plan for the work to have been done piecemeal, or to have occupied several generations. The earlier date would also displace Serpens and Scorpio from their very significant relation to the colures.—E. WALTER MAUNDER.]

The Cygnus "Coal-Sack."

TO THE EDITORS OF "KNOWLEDGE."

SIRS,—In the Milky Way, a little north of the "Northern Cross"—between the stars ξ and ρ Cygni, in fact—I have frequently observed a black rift cutting the course of the Via Lactea transversely. Do you mind explaining the nature of this phenomenon?

The appearance does not seem to be due to the presence of a dark nebula, because very moderate telescopic aid reveals faint stars in its recesses.

Have we here a veritable opening in our island-universe—a sort of tunnel through which we may peer into the sparsely-lit infinity beyond?

Yours faithfully,
J. B. WALLIS.

Alderwasley, nr. Wirksworth, Derbyshire.
November 14, 1904.

[The rift to which Mr. Wallis draws attention is clearly shown on Dr. C. Easton's charts of "La Voie Lactée." The phenomenen is doubtless of the same nature as the other numerous rifts, channels, and gaps in the Milky Way; they cannot be due to the interposition of dark absorbing nebulæ, but are evidently integral parts of the Galactic structure.—E. WALTER MAUNDER.]

The Teaching of the Principles of Evolution in the Schools.

TO THE EDITORS OF "KNOWLEDGE."

SIRS,—Over a quarter of a century ago Professor Virchow said: "If the theory of descent is as certain as Professor Haeckel thinks it is, then we must demand its admission into the school, and this demand is a necessary one." I think the time has arrived when all educationists should consider the desirability of teaching children the principles of evolution. I believe all the sects accept the evolution theory, and it would not be difficult to present the facts in such a way that children could understand them.

Yours faithfully,
J. A. REID.

Kineraig, Cutcliffe Grove, Bedford,
November 18, 1904.

REVIEWS OF BOOKS.

Earthquakes.—If it were possible to find a peg for criticism in so admirable a work as Major C. E. Dutton's "Earthquakes in the Light of the New Seismology" (John Murray), it would not be in the book but in the fact that the first general digest of the knowledge and views which are associated with the work and theories of Professor John Milne, Professor Ewing, Professor Nagaoko, of Tokio, Major De Montessus de Ballore, and Dr. Emil Rudolph, of Strassburg, should have been made by an American rather than by an English man of science. However, science is the true cosmopolitan influence, and it behoves us to regard Major Dutton's able, patient, and judicious examination of what the best authorities think and know of a subject which has a fascinating interest for all mankind, as an instance of it. A happy distinction is made in Major Dutton's introduction between the standpoint of the new seismology and the old. The old view of earthquakes was that they were one of those formative geologic forces, almost as mysterious and axiomatic as the occurence of matter itself, which existed in order to bring about structural results. The new view regards earthquakes as merely the effect of geologic forces, just as thunder is an effect of the electric discharge—not the cause of it. As a sound is the elastic vibration of the air, so an earthquake is merely the elastic vibration of the earth mass. Hence the science becomes in a great measure the investigation of elastic wave motion in a solid medium. That investigation became possible with the invention of the seismograph, the earth-tremor measurer; and the correlation of the results which the seismograph afforded was primarily the work of John Milne. He has been followed by hosts of patient investigators in every country of the world; and Major Dutton's book is a summary of the results and conclusions at which they have arrived. His earlier chapters set forth the nature of earthquakes and discuss their double causation, volcanic and "stratagic," if we may coin a word to replace the usual one of "tectonic." Chapters descriptive of the instruments used are followed by others which enter exhaustively into the character, characteristics, and theoretic features of the various kinds of earth tremors or waves which agitate the earth's mass and the earth's crust. Chapter XIII. takes up the question of speed of propagation, its connection with the relation of elasticity to density; and the light which is consequently thrown on the densities of the earth's interior at varying depths. The last chapters indicate the general distribution of earthquakes, and the index they afford of the points of origin of great seismic disturbances, both on land and in the depths of the sea. The volume is one of the most interesting which has appeared in the "Progressive Science Series," and will appeal to a world-wide audience.

"The Mathematical Theory of Eclipses," by Roberdean Buchanan, S.B. (J. B. Lippincott Company, Philadelphia and London, 1904). This work is designed for the computer of solar and lunar eclipses, and not for the use of the practical observer. The author is eminently fitted for his task, as he has been engaged for the last 24 years on the computation of eclipses for the American Ephemeris. The book is based on Chauvenet's chapter on eclipses in his "Spherical and Practical Astronomy," but the great experience of Mr. Buchanan has led him to sift out the unnecessary formulæ from the necessary, and to arrange their order into a more convenient form for computation. A graphic method is also employed for explaining the formulæ:—"The eclipse is dissected after the manner of a surgeon—it is cut up and the hidden parts laid open to view." Mr. Buchanan observed the total eclipse of 1900, May 28, at Newberry, South Carolina, where he gave special attention to the shadow bands, and this feature is the only observational one connected with eclipses with which he treats. The cause of the shadow bands is still doubtful, but Mr. Buchanan is inclined to attribute them to the undulations and disturbances of the density of the atmosphere within the core of the shadow, caused by the lower temperature of the cone (which may fall by 4° or 5°), thus producing intermittent opacity. He also explains the factor producing the "Black Drop" in a transit of Venus or Mercury, and "Baily's Beads" at the second and third contacts of the moon with the sun. He also clearly disposes of the somewhat widely-spread idea that the darkness at the Crucifixion was caused by an eclipse of the sun; this could not be, since a solar eclipse can only occur at new moon, and the Feast of the Passover (upon the eve of which the Crucifixion took place) was appointed by the law to be held at the full moon of the first month.

Chemical Engineering.—A second edition of Mr. George E. Davis's "Handbook of Chemical Engineering" has been published by Messrs. Davis Brothers, of Manchester, and the

necessities of enlargement and revision, which are imposed on such a work by the development of modern practice and scientific investigation of methods, are very liberally complied with. The ample space of these two volumes, numbering over a thousand pages and comprising more than five hundred illustrations, permits of the most complete consideration of the growing requirements of industries which continually show expanding necessities and unbounded possibilities. The volumes, primarily designed for the use of the works manager, are written with a view to be of interest and instruction to the student also. This is the more evident in the second volume, where considerable additions have been made to the theoretical consideration of questions connected with the absorption and compression of gases; and to the application of electricity to the chemical and allied industries. Our space will not permit us to enter into a detailed examination of Mr. Davis's standard of theoretical requirement in the information which he gives on his subjects; but we may note that in the chapters relating to gases and to heat the theoretical side of the questions considered receives treatment which is equally full and lucid. It will be of greater service both to Mr. Davis and to intending purchasers of his valuable volumes to enumerate briefly the new features which have been added to the second edition. In the chapters dealing with steam and power, the subject of water softening has been more fully treated, and the flow of steam through pipes investigated by the light of the latest information on the subject. The flow of viscous liquids through pipes and the cost of moving gases by various methods receive a good deal of attention; and suction producers, the Diesel engine, and the De Laval steam turbine are now fully described. The first volume concludes with a chapter on the treatment and preparation of solids; the second begins with three chapters on heat and the compression and absorption of gases to which we have referred. In connection with the applications of electricity, the electro-smelting furnaces of Stassano, Heroult, Harmet, and Kjellin are both described and illustrated. But perhaps the most important addition to this subject is the information given relating to the comparatively new industry of electro-magnetic separation, which is very fully described and illustrated. All the various systems of magnetic separation have been noticed and many figures of separations from actual practice have been included in the work. Increased attention has also been given to the subjects of hygiene, and especially to accidents and to the treatment of cases of gaseous poisoning. In this connection, the construction and use of respirators has secured additional space, which it is hoped will lead to an extension of knowledge of this important subject.

"The Rob Roy on the Jordan" (John Murray) carries its thirty and odd years lightly. The present eighth (2s. 6d. net) edition of Mr. Macgregor's canoe cruise in Palestine, Egypt, and the waters of Damascus is as fresh as the day it was written. The most interesting point of a narrative that is full of interest is Mr. Macgregor's description of his discovery of the mouth of the Jordan, which "eludes our sight by diving into jungle, where it defies all search from the north side as to where its waters roll into this Lake of Nierom." He found it entering the lake at the end of a promontory of papyrus of the richest green, and upright as two walls on either hand. Apart from the intrinsic interest of the matter the *naïveté* of the style lends it additional charm.

Light and Water.—The luxurious and attractive volume which Sir Montague Pollock calls "Light and Water" (George Bell and Sons) is described by him, in his secondary title, as a Study of Reflexion and Colour in River, Lake, and Sea. It is, in fact, an attempt to state the elementary scientific principles which govern the reflexion of light from water, in such a way as to be a guide to the artist or art student. The book serves its purpose admirably; the simpler laws of optics are stated in terms that are comprehensible to the meanest intelligence, and the author's very agreeable style should commend his book not merely to artists, but to any lover of Nature. Numerous and beautiful illustrations, especially those accompanying the chapters on colour in water, have a value and interest in themselves.

Physical Science.—We must confess to no great predilection for works which summarise in a compressed form half a dozen scientific problems. But an exception must be made in the instance of "The Recent Development of Physical Science," by W. C. D. Whetham, F.R.S. (John Murray), which sets out the conceptions of gaseous liquefaction, of radio activity, of atoms, electrons, ions, and the ether, the consideration of which has become the theme almost of household discussions. Often books of the kind are very loosely scientific, and, in the attempt to interest, are neglectful of the necessity to instruct. But Mr. Whetham takes a very different view of his responsibilities. He relates the various problems one to the other; he shows what common basis they have; he compares discovery with theory; he interprets the philosophical aspect of scientific endeavour in physical science. To his task of interpretation he brings a pen of singular clearness, and a manner that is graphic, illustrative and succinct. Such an essay may be compared to the best form of public lecture. It demands intelligence on the part of the auditor, but its underlying purpose is to direct that intelligence into channels of greater and more complete information. It would be a very poor compliment to Mr. Whetham to describe his work as popular in the ordinary sense of the expression, but in the better sense, as a book of the greatest utility and interest to the educated public, it may be so considered.

Sociology. Mr. J. Lionel Tayler's "Aspect of Social Evolution" (Smith, Elder, and Co.) is a suggestive contribution to the new science of Eugenics. It has been more than once pointed out, and that by observers in widely distributed fields of observation, that the improvement of the race cannot be scientifically effected by any scheme that our knowledge can at present propound. There seems, in fact, to be no way of improving the race better than that which was suggested by the late R. L. Stevenson in the words that "one person I have to make good—myself. My duty to my neighbour is better expressed by saying that I have to make him happy—if I can." But at the root of happiness and of goodness lies increased and better knowledge; and in a true appreciation of the difficulties and of the problems is the only hope of the betterment of the race. It is for these reasons that such honest efforts as those of Mr. Tayler to state the problems and the difficulties are to be welcomed.

Natural History. There is a great deal of charm about Mr. Graham Renshaw's "Natural History Essays" (Sherrat and Hughes), which gather together in a convenient form and in a capitally illustrated book a number of articles on well-known or little animals, typical examples of the mammalian African fauna, such as the Barbary Ape, the Fennec Fox, the Blue Wildebeest, the White Rhinoceros, and that "True Quagga," the extinction of which, though proved, is constantly denied by honest but uninstructed hunters of South Africa. A pleasant gossipy, and withal a sound and valuable book.

Babington's Manual of British Botany. A ninth edition has been published of the late Professor Babington's "Manual of British Botany" (Gurney and Jackson), which contains the flowering plants and ferns arranged according to the natural orders. The present edition of this useful work, for many years almost the only critical handbook of British flora, has been edited by Henry and James Groves, who have included the notes prepared by its author with a view to a subsequent edition, together with the results of recent work in botany.

Flowering Plants and Ferns. A second edition in one volume has appeared of Mr. J. C. Willis' useful guide to the students of botany, "A Manual and Dictionary of the Flowering Plants and Ferns" (Cambridge University Press). It is in fact a summary of scientific information about the plants to be found, either in a botanical garden or in the field, and it embraces the subjects of morphology, classification, natural history, and economic botany. It is well adapted both for home study or for work in the country, especially as the descriptions of genera are not unnecessarily technical.

The Timbers of Commerce.—"The Timbers of Commerce and their Identification" (William Rider and Sons), by Hubert Stone, F.L.S., F.R.C.I., consists of an exhaustive tabulation and characterisation of the various woods used in trade. Under the heading of each wood is given its botanical classification, its source of supply, its physical characteristics, its uses in commerce, together with its numerous other qualities, and fine photographs show sections of the principal kinds

mentioned. In his introduction and chapter on practical hints Mr. Stone speaks of his subject with knowledge and enthusiasm, and it should be a valuable handbook to experts.

Miscellaneous.

Photography.—We have received for review five volumes of the "Photography" Bookshelf series, published by Messrs. Iliffe and Son at 1s. They are intended for practical purposes, are simply written, and sufficiently illustrated. No. 10, "Practical Retouching," containing hints for after treatment of the negative by Drinkwater Butt, F.R.P.S., now appears as a second edition. In No. 15, which deals with "Intensification and Reduction," Mr. Henry W. Bennett considers the methods that experience has proved to be most successful in the process of strengthening or modifying negatives. Nos. 17 and 18, on "Professional Photography," by C. H. Hewitt, contain chapters on such subjects as the Background, Portraiture Outside the Studio, Lighting the Features, and Principles of Composition. No. 5, "Photography in Colours," by R. Child Bayley, F.R.P.S., appears as a second edition.

Malabar and Its Folk (Natesan and Company, Madras), by T. K. Gopal Panik-Kar, B.A., describes the social customs and institutions of Malabar. It contains a good deal of curious and interesting matter, set forth in a quaintly picturesque language, of which the following is a typical example: "Fields laden with heavy corn waving yellow in the tepid breeze, in which the busy day-labourer, basking in the fierce glare of a summer sun, now wipes a brow sprinkled over with drops of honest toil, afford a rare and amusing spectacle. Now chanting his wild notes, now goading and striping the lazy bullocks plodding through the hardened mead, he adds to the amusement of the scene."

The Optics of Photography and Photographic Lenses (Whittaker and Co.; price, 3s. 6d.), by T. Traill Taylor, is published as a third revised edition, with an additional chapter on Anastigmatic Lenses, by P. F. Everitt.

The London University Guide, 1905 (University Correspondence College) contains regulations for the Examinations to be held in 1905-6.

The Matriculation Directory (University Correspondence College, Burlington House, Cambridge) contains the Examination Calendar for 1904-5, with advice as to subjects and text-books and specimen papers and answers.

The King's English and How to Write It (Jarrold and Sons), by John Bygott and A. J. Lawford Jones.—A practical text-book of essay and *précis* writing appears in a sixth revised edition.

Lectures Scientifiques (Rivingtons), by W. G. Hartog, B.A., of University College, London, supplies a definite want and is admirably arranged. Some familiarity with French and German scientific terms is now essential to all students of science, and more especially so since the University of London has prescribed that a candidate for a scientific degree must be able to read and understand French and German scientific work. "Lectures Scientifiques" consists of extracts from modern French scientific writers on the various branches of science, with a glossary of scientific terms.

One Thousand Objects for the Microscope (Frederick Warne and Co.), by M. C. Cooke, M.A., gives practical hints for the use of the microscope, with lists of objects suitable for mounting. It is written in a pleasant, popular style, with numerous illustrations, and is admirably adapted to the use of the amateur microscopist.

Private House Electric Lighting (Percival Marshall and Co.), by Frederick H. Taylor, is a practical popular handbook designed for the use of the amateur electrician who wishes to acquaint himself with the best modern methods of the installation of electric light in private houses. It is useful and comprehensive.

First Stage Magnetism and Electricity (University Tutorial Press), by R. H. Jude, M.A., D.Sc., appears as a new and revised edition. It is divided into three parts—I., Electrostatics; II., Magnetism; III., Voltaic Electricity—and is designed to meet the requirements of a young engineer.

First Stage Steam (University Tutorial Press), by J. W. Hayward, M.Sc.,Vict., is intended to meet the requirements of the Board of Education examination. It includes examples of examination papers from 1901 to 1904, and suggestions for simple experiments, and is illustrated by numerous useful diagrams.

Modern Philosophers and the "Per Quem" (Elliot Stock), by George Edward Tarner, is a conscientious attempt to re-affirm the doctrinal tenets of Christianity, somewhat on the lines of Patey's "Evidences."

The Seven Lamps of Architecture is published by Mr. George Allen in one volume at 3s. 6d. among his reprints of Ruskin's works. This charming little edition is strongly bound, well printed, and beautifully illustrated. Ruskin lovers will gladly avail themselves of this opportunity of obtaining his works at so low a price.

The Museums Journal (Vol. III., Dulau and Company), edited by E. Howarth, forms a useful book of reference, and a compendium of information about museums at home and abroad, while its numerous illustrations afford interesting opportunities of comparing the methods of arranging and exhibiting specimens in English and foreign museums.

The Reliquary and Illustrated Archæologist (Bemrose and Sons), Vol. X., is a delightful possession. Among many of its interesting and elaborately-illustrated articles are "Notes on a Roman Hydraulus," "The Evolution of the Mitre," and "Medallic Portraits of Christ."

We have also received Part VI. of Messrs. Hall and Steven's "School Geometry" (Macmillan), the general principles of the methods of which have already received favourable notice in our columns; and "Elementary Plane Geometry" (Blackie and Son), by Mr. V. M. Turnbull, which proceeds on the Cambridge method of following up the experimental work of measurement and calculation with deductive geometry.

We have received from Mr. John Murray Professor W. H. Pickering's monograph on "The Moon," and Dr. George Newman's "Bacteriology and the Public Health," both of which will be fully noticed in our columns next month. We have also received for review "Light Energy," by Miss Margaret A. Cleaves (Rebman, Limited), which will also be further noticed.

We have also received "Eton Nature Study," by M. D. Hill and W. Mark Webb (Duckworth and Co.)—a book which has every title to attain its desired aim of inculcating the teaching of natural history and botany in schools; and "Nature Teaching," by Francis Walts and W. G. Freeman (John Murray), which aims at teaching botany to the schoolboy from an agricultural and horticultural standpoint. It is excellent alike in aim and plan.

Messrs. Darton's Electrical Novelties.—We have received Messrs. Darton's new catalogue of electrical novelties. The novelties are chiefly of the kind associated with the many uses to which electricity, with its great capacity for sub-division, can be put in the household and the laboratory. The small motors are specially adaptable to such uses; the dynamos and small gas-engines are susceptible of application to larger purposes. Besides these, there are the many varieties of electric lamps with light dry cells which can be used for bedside illumination, for bicycles, or for railway travelling; accumulators for motor-car ignition; electric bells and their accessories; house telephones; medical magnetic coils; induction coils, and other devices of an analogous character.

A Microphotograph of Fossil Coal.

THE accompanying Microphotograph of Fossil Coal is one of those with which Mr. Thos. E. Freshwater, F.R.M.S., F.R.P.S., won a Silver Medal this year at the St. Louis International Exhibition, and is reproduced by his courteous permission. The coal of which it is a photograph occurs at Bath, in Scotland; and the photograph was taken on an Ilford ordinary plate, with a Zeiss Planar lens, 20 m.m. focus; at an angle of 65 deg., and with a 24-inch extension of the camera.

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, F.R.M.S.

Royal Microscopical Society.

AT a meeting held on October 19 at 20, Hanover Square, Dr. Dukinfield H. Scott, F.R.S., President, in the chair, Mr. Rousselet described a Lucernal microscope, further portions of which had been presented by Mr. Orfeur. The instrument bore no maker's name, but was built on Adams' model and was probably of a rather later date than his time. A description of this maker's "Improved and Universal Lucernal Microscope" will be found in Adams' Essays on the Microscope, 1787. The Secretary called attention to micro-photographic portraits of Prof. Quekett and two others who were unnamed, but which were identified as being likenesses of Dr. Letheby and Dr. John Millar. A communication from Mr. W. D. Colver was read describing the antenna of *Pulex irritans*, on the terminal joint of which Mr. Wm. Jenkinson, of Sheffield, had discovered a lamellated structure which he believed to have an olfactory function. Mr. Jenkinson had found similar structures in several other members of the family of the Pulicidæ. A slide showing the entire antenna, and another showing the terminal joint, were exhibited under microscopes, and photographs of the latter slide were also exhibited in the room and on the screen. Part xvii., the concluding part of Mr. Millett's Report on the Recent Foraminifera of the Malay Archipelago, was taken as read, and will be duly published in the Society's journal. The President then gave a demonstration on "The Reconstruction of a Fossil Plant." The plant selected was *Lyginodendron Oldhamium*, and the growth of our knowledge of its structure was illustrated by actual sections and lantern slides shown on the screen. The identification of the stem of a Pinites, the fern-like petiole of *Rachnöpteris aspera*, and the foliage of *Sphenopteris Hönnighausi* as being corresponding parts of Lyginodendron was demonstrated. It was discovered that the stem was frequently branched, and certain fossil seeds are now, on structural evidence and association, considered to be the fruit of this plant. The reconstruction of the plant is, however, still incomplete, as the male organs have not yet been identified with certainty. The position of Lyginodendron as a seed-bearing plant allied at once to Cycads and Ferns was now established. A picture of the reconstructed plant was shown on the screen, and models of the seed, kindly lent by Prof. F. W. Oliver, were exhibited.

The Quekett Microscopical Club.

The 416th ordinary meeting of the Club was held on October 21 at 20, Hanover Square, W. There was an unusually large attendance of members, and the long list of new members proposed for election gave proof of the strong position held by the Club, which will shortly celebrate its fortieth anniversary.

Messrs. W. Watson and Sons exhibited their latest designs and models, both of microscopes and apparatus, together with some very fine slides, principally of marine life.

Mr. F. P. Smith gave a very interesting lecture on the "Spiders of the Erigone group." He described at some length the most striking feature of the sub-Family, viz., the extraordinary formation of the caput in the males. In this sex the caput is almost always of a form different from that of the females, being, as a rule, more or less raised. It was generally thought that such elevation of the caput was intended to extend the field of view, but this seemed doubtful, as the eyes which were placed at the top of the elevation were sometimes so feebly developed that they would gain little or nothing from such elevation. In other species again the eyes were not placed on the summit of the elevation, and in some the elevation was so placed as to obstruct the field of view.

Mr. Smith then dealt with the classification of the group, suggesting a re-arrangement of certain genera and the creation of two new genera for existing species.

Two very old members of the Club, both well known in the microscopical world, have passed away during the last month.

C. G. Dunning joined the Quekett Club in October, 1872, and was on the Committee from 1876 to 1879. He died on September 29. Being of a mechanical turn of mind, he devoted himself to the improvement of microscopical accessories, and invented an improved form of turntable, a portable microscope lamp, and a trough, all of which bore his name, and were in demand in their time, though now superseded by later models.

Edward Dadswell, F.R.M.S., joined the Club in January, 1875, and with the exception of one year, 1882, he served continuously on the Committee from 1879 to 1903. As one of the most familiar figures at the Club, and prominent in its social life and excursions, he will be greatly missed, although he had not been able to attend for more than a year previous to his death. He died on October 6, and the interest which he had always displayed in the Club is marked by a legacy of £50, which he has bequeathed to it in his will.

Staining and Preserving Algae.

J. Q. T. writes from Queensland giving the following particulars of a method of staining and preserving algæ, which he has found very satisfactory. The reagents required are made up as follows:—*Fixing solution:* Chromic acid, 1 oz.; glacial acetic acid, 4 oz.; formaldehyde as formalin (Schering's), 4 oz. *Preserving fluids:* Best glycerine, 8 ozs.; glycerine jelly, 1 oz. *Chromo-acetic acid:* Chromic acid, 1 gramme; acetic acid, 1 cc.; water, 100 cc. *Formalin* (4 per cent.); Schering's formalin, 10 cc.; water, 90 cc. (for a 2 per cent. solution take half the quantity of formalin). *Stains:—Haemalum* (Grübler); *Haematoxylin solution:* Haematoxylin cryst. puriss., 1 gramme; water, 200 cc. *Iron alum solution:* Iron alum, 3 grammes; water, 100 cc. (The iron alum should lie in pale violet crystals, not yellow or green, and should be kept in an air-tight tube.) *Eosin solution* (water soluble): Eosin, 1 gramme; water 200 cc.

The material, which may be "fruiting" or sterile, is gathered in jars and brought home in water, or can be placed directly in the fixing solution at the time of

gathering, this last being generally preferable. If fixed in the chromo-acetic mixture it will require about twelve hours for thorough fixation, and twenty-four hours in the formalin. After chromic acid, the material must be washed in running water or frequent changes for at least one hour, or, better, for three hours. The following simple little piece of apparatus is very useful for washing. It consists of a test-tube fitted with a cork, through which two pieces of glass-tube pass. One of these is connected to a water-tap by a piece of rubber tubing, which, in turn, is connected to a piece of glass tubing passing through a cork jammed in the mouth of the tap. A piece of thin muslin is tied over the end of the other tube inside the jar to prevent the escape of specimens. With formalin no washing is necessary.

The material being fixed, the next question is the stain. If nuclei are the only details required, Haemalum will be the best to use. It should either be used strong for five minutes, or diluted (1 cc. to 50 cc. of water) for twenty-four hours. The staining must be carefully watched in both cases. Overstaining may be remedied by water acidulated (.1 per cent.) with hydrochloric acid, but the method is somewhat risky. The other methods of staining are as follow:—Stain with iron alum solution for three hours, wash in running water for one hour. Stain in Haematoxylin solution for six to twelve hours. Now comes the delicate part, for the tissues are much overstained, and must be washed in the iron solution till the details are brought out, examining with the microscope the whole time. Immediately the details are out (generally in about a quarter-of-an-hour), the decolourisation is stopped by placing the object in tap or rain water. Now place some water in a watch-glass and add 5 per cent. of glycerine. Transfer the algae to the dilute glycerine and cover it with an inverted watch-glass, to prevent dust without checking evaporation. Leave until the glycerine is thick enough for mounting, mount in a shallow tin cell in just enough glycerine to fill the cell (this requires some practice), seal with gold size, and when dry ring with Brunswick Black. In some cases a contrast stain may be desired. This can be obtained by placing the tissue in the eosin solution for 30 seconds or less, previous to the transference to the 5 per cent. glycerine.

Notes and Queries.

Resolution of Amphipleura pellucida.

Mr. C. Mostyn (of Ramsgate) writes: Your paragraph in "KNOWLEDGE" on resolving Amphipleura induces me to describe a method I have lately hit upon, which may possibly not be known to all microscopists. It has the merit of extreme simplicity, not even requiring a sub-stage condenser, or, in fact, any extra appliance whatever, except a sufficiently powerful source of light, and giving the most brilliant resolution ("false resolution," so called, of course) that I have ever obtained, even with immersions and condensers of great N.A. It happens that my microscope (a "Star") has the very useful fitting of a mirror that can be swung up above the stage for opaque objects. It occurred to me to experiment in the direction of obtaining a "dark ground" or "opaque" illumination with high powers, preferably immersions, by concentrating light on the film of immersion fluid. I tried, among other experiments, a slide of Angulatum, mounted in realgar, with a $\frac{1}{12}$" water immersion, N.A. 1·18, and sunlight. The result was the most beautiful exhibition of the diatom I have ever seen. The diatom, by a little careful handling of the mirror, appeared of a brilliant emerald colour on an ink-black ground—or a light ground could be had at will—and with excellent definition and resolution, free from fog or diffraction effect. This success induced me to try upon Amphipleura and Frustulia Saxonica, both of which were most brilliantly resolved. I fancied I could, on some valves, detect the longitudinal striæ of Amphipleura as well; but the want of a rotation to the stage prevented me from examining the valves in the best manner. I may add that the objectives, with a dry condenser of N.A. 1·0, had hitherto failed to give resolution, try as I would, with or without stops, though an oil lens of N.A. 1·25 would do it easily. I then tried a Zeiss $\frac{1}{20}$"—an old water-lens, whose N.A. does not, I think, exceed 1·10—and it resolved Amphipleura equally well. I have seen many expert hands take half-an-hour to effect a satisfactory display; a minute or two is the outside required with my plan, given a sufficient amount of light. An ordinary microscope lamp, with half inch wick, is not powerful enough. Of course, a bull's-eye can be used instead of a mirror; but it is not nearly as easy to manage.

I have been told that mine is merely a re-discovery of the "Bramhall Illuminator," but that was a slip of looking-glass placed below the slide, and on a different principle altogether, though, I believe, very effective in the pre-immersion days. I shut off all light from below the slide altogether, with a closed iris.

Galls on Oak-leaves. *H. W. Fenton, Handsworth.*

The brown gall on the oak-leaf you sent is a Cynipid gall, that of *Neuroterus lenticularis*. The gall appears in July and matures in September, falling to the ground about the end of that month or the beginning of October. This autumn generation is parthenogenetic, but another and a sexual generation appears in the spring in quite different spherical galls known as *Spathegaster baccarum*. The gall on the midrib of the same leaf is *Neuroterus ostreus*, whilst the gall with a depressed centre on the other oak leaf is *Neuroterus numismatis*, which matures with *N. lenticularis*. These and many other galls were exhibted by Mr. E. R. Burdon, of Sidney Sussex College, at the last meeting of the British Association held in Cambridge, and Mr. Burdon has been good enough to name the above species for me. You will find the subject dealt with in "Alternating generations; a biological study of oak-galls and gall-flies," by Hermann Adler, translated by C. R. Straton, and published by the Clarendon Press in 1894. In this book you will find instructions as to rearing the flies—the eggs themselves can be easily dissected out if you wish to do so. I do not think you could turn your attention to a more interesting branch of study or one offering more opportunities for original work, as the whole subject has been neglected by all but a very few workers.

John Hume, Newcastle-on-Tyne. The gall you sent is that of *Neuroterus lenticularis* mentioned above.

H. W. Harvey, Norfolk. What you thought to be a fungus is the same gall. With regard to the "second sting" you speak of, the drawing you send is not sufficient to enable me to pronounce an opinion, but these stings are generally made of a couple of darts which join together so as to form a canal down which the poison passes into the wound. Is it not possible that you have split one of these, or even damaged their sheath, and so formed an erroneous impression?

Derivation of Names of Diatoms.

Rev. W. Hamilton Gordon, of Fareham, Hants, would be glad if any reader could give the derivation of the names *Surirella* and *Nitzschia* as applied to diatoms. I think there can be no doubt that the latter diatom was named after the worm of the same name, but that does not bring one much nearer. With regard to the distribution of diatom material, I am dependent entirely on the generosity of such readers of my notes as have material of one sort or another which they are good enough to send me for distribution to others.

(Communications and enquiries on Microscopical matters are invited, and should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.)

The Face of the Sky for December.

By W. Shackleton, F.R.A.S.

The Sun.—On the 1st the Sun rises at 7.45, and sets at 3.53; on the 31st he rises at 8.8, and sets at 3.58.

Winter commences on the 22nd, when the sun enters the sign of Capricorn at 6 a.m. Solar activity is well marked, and sunspots, faculæ, and prominences may be observed on any favourable occasion.

For physical observations of the sun the following ephemeris may be used:—

Date.	Axis inclined from N. point.	Centre of disc, N or S of Sun's equator
Dec. 1 ..	16° 6′ E.	0° 38′ N
,, 11 ..	11° 56′ E.	0° 38′ S
,, 21 .	7° 10′ E.	1° 54′ S
,, 31 ..	2° 30′ E.	3° 6′ S

The Moon:—

Date.	Phases.	H. M.
Dec. 7 ..	● New Moon	3 46 a.m.
,, 14 ..	☽ First Quarter	10 7 p.m.
,, 22 ..	○ Full Moon	6 1 p m
,, 29 ..	☾ Last Quarter	3 46 p.m.

Occultations.—

Date.	Star's Name.	Magnitude	Disappearance.			Reappearance		
			Mean Time.	Angle from N point	Angle from Vertex.	Mean Time.	Angle from N point	Angle from Vertex.
			p.m.			p.m.		
Dec. 20 .	γ Tauri	3·9	6.1	90	130	7.4	239	275
,, 20	θ Tauri .. .	3·9	11.25	145	130	11.58	195	173
			a.m.			a.m.		
,, 21..	α Tauri	1·1	3.19	57	17	4.12	205	255

The Planets.—Mercury is an evening star in Sagittarius, setting about an hour after the Sun until the 25th; he attains his greatest easterly elongation of 20° 30′ on the 14th. The planet is in inferior conjunction with the Sun on the 31st.

Venus is rapidly coming into a more favourable position, and towards the end of the month is well visible in the evenings. On the 1st she sets about 6.15 p.m., and on the 31st about 7.45 p.m. The apparent diameter of the planet is increasing, being 15″ on the 15th, whilst 0·75 of the disc is illuminated.

Mars is a morning star in Virgo, rising about 1.38 a.m. on the 15th.

Saturn is getting more to the west and also diminishing in brightness. About the middle of the month the planet is on the meridian at sunset, and sets about 8.15 p.m. The ring is widely open, the diameters of the major and minor axis of the outer ring being 37″·1 and 9″·7 respectively, whilst the polar diameter of the ball is 14″·8.

Uranus is unobservable, being in conjunction with the Sun on the 22nd.

Neptune rises about 9 p.m. near the middle of the month. He is situated about 14 mins. east of the star μ Geminorum, as will be seen on reference to the chart given in the January number. The planet is in opposition on the 28th, hence about this time he souths near midnight.

Jupiter is in a very favourable position for observation in the early evenings, being on the meridian about 8 p.m. near the middle of the month; also throughout the month he is visible from sunset until early morning.

The equatorial diameter of the planet on the 15th is 45″, whilst the polar diameter is 2″·9 smaller.

The configurations of the satellites, as seen in an inverting telescope at 9 p.m., are as follows:—

Day	West	East.	Day.	West.	East.
1		1○324	16		3○124
2		3○124	17		312○4
3		321○4	18		32○14
4		32○14	19	●	1○24
5	●	○$^{4}_{3}$2	20		○1234
6		41○23	21	●	2○43
7		42○13	22		12○43
8	●	41○3	23		43○12
9		43○12	24		4312○
10		43$^{2}_{1}$○	25		432○1
11		432○1	26		413○2
12	●	41○2	27		4○123
13		4⊙23	28	●	42○3
14		2○$^{1}_{4}$3	29		4$^{1}_{2}$○3
15	●	1○34	30		$^{3}_{4}$○12
			31		31⊙4

The circle (○) represents Jupiter; ⊙ signifies that the satellite is on the disc; ● signifies that the satellite is behind the disc, or in the shadow. The numbers are the numbers of the satellites.

Meteors:—

The principal shower of meteors during the month is the Geminids, December 10th to 12th; the radiant is in R. A. VII.h 12m, Dec. + 33°. The meteors are short and quick, and difficult to record accurately.

Encke's Comet was again photographed by Max Wolf on October 28, when its magnitude was 12·5.

The comet is increasing in brightness, being in perihelion on Jan. 4, hence it should be visible in ordinary telescopes early in the month; after the first few days, however, the Moon and the comet's motion into daylight will make observation impossible.

The following ephemeris is for Berlin noon.

Date.		Right Ascension.	Declination.
		h. m. s.	° ′
Dec. 1	..	21 13 11	+ 9 35·1
,, 2	..	21 9 31	9 0·0
,, 3	..	21 5 51	8 24·6
,, 4	..	21 2 11	7 48·9
,, 5	..	20 58 32	+ 7 13·0

Minima of Algol may be observed on the 1st at 10.22 p.m., on the 4th at 7.11 p.m., 7th at 4.0 p.m., 22nd at 0.5 a.m., 24th at 8.54 p.m., and 27th at 5.43 p.m.

Telescopic Objects:—

Double Stars:—1 Pegasi XXIh 17.5m, N.19° 20′, mags. 4·5, 8·6; separation 36″·2.

π Andromedae 0h 31.5m, N. 33°·11′, mags. 4·0, 8·0; separation 36″·3.

α Piscium Ih 56.9m, N. 2°·17′, mags. 3·7, 4·7; separation, 3″·6

ι Trianguli IIh 6.6m, N. 29°50′; mags. 5, 6·4; separation 3″·5.

Clusters:—(H VI. 33, 34). The Perseus clusters visible to naked eye and situated about midway between γ Persei and δ Cassiopeiæ. These magnificent clusters are described by Smyth as "affording together one of the most brilliant telescopic objects in the heavens."